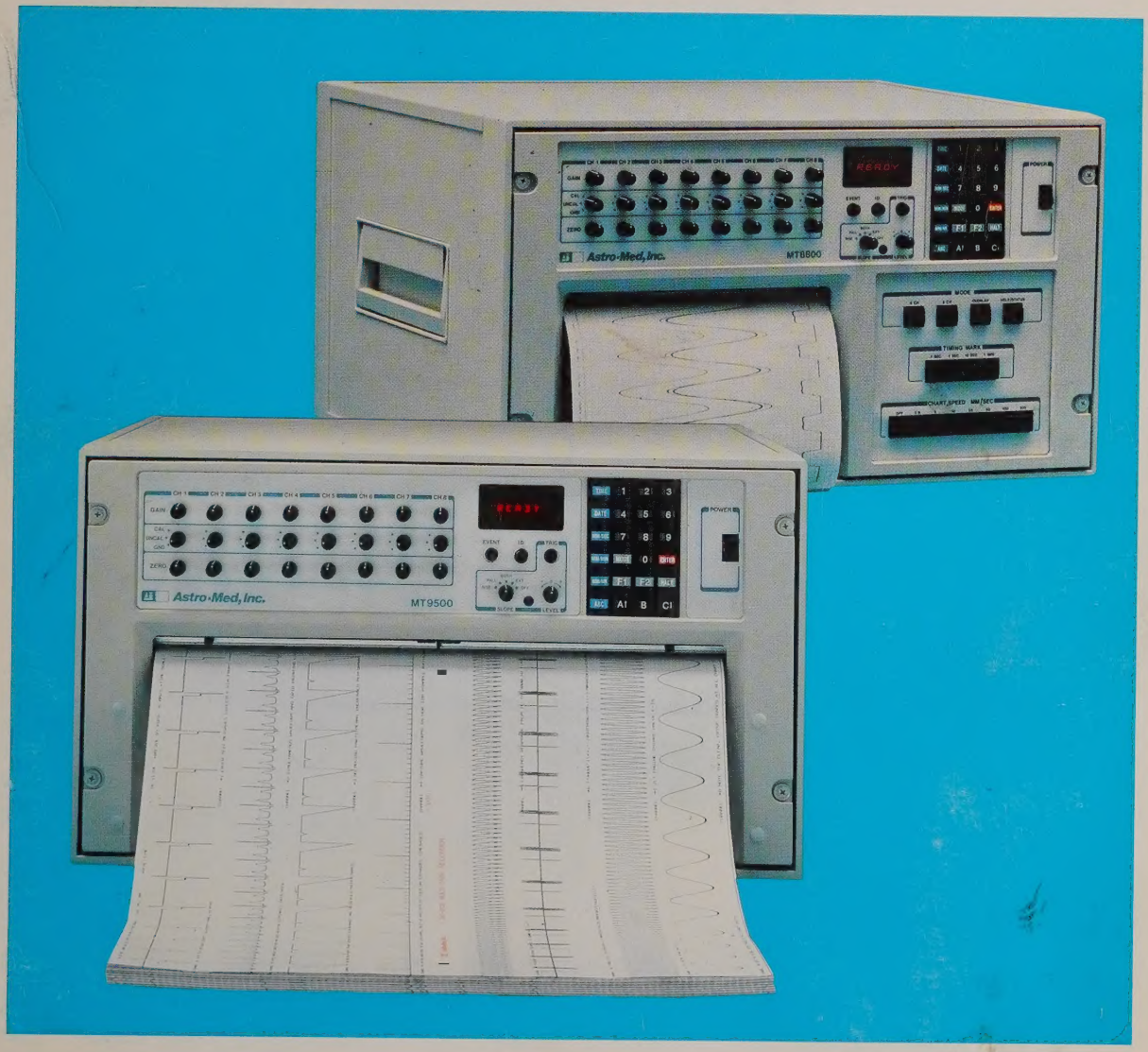
Host Control Operations Manual

MT·8800 / MT·9500 / MT·9000 Recorders



Astro-Med, Inc.

MT-8800/9500/9000
Host Control
Operations
Manual

Astro-Med
Part Number
22834089

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Model Number:_____

Serial Number:_____

Software Version:_____
(original installation)

Upgraded Software Version:_____
(date installed: ___/___/___)

Upgraded Software Version:_____
(date installed: ___/___/___)

Upgraded Software Version:_____
(date installed: ___/___/___)

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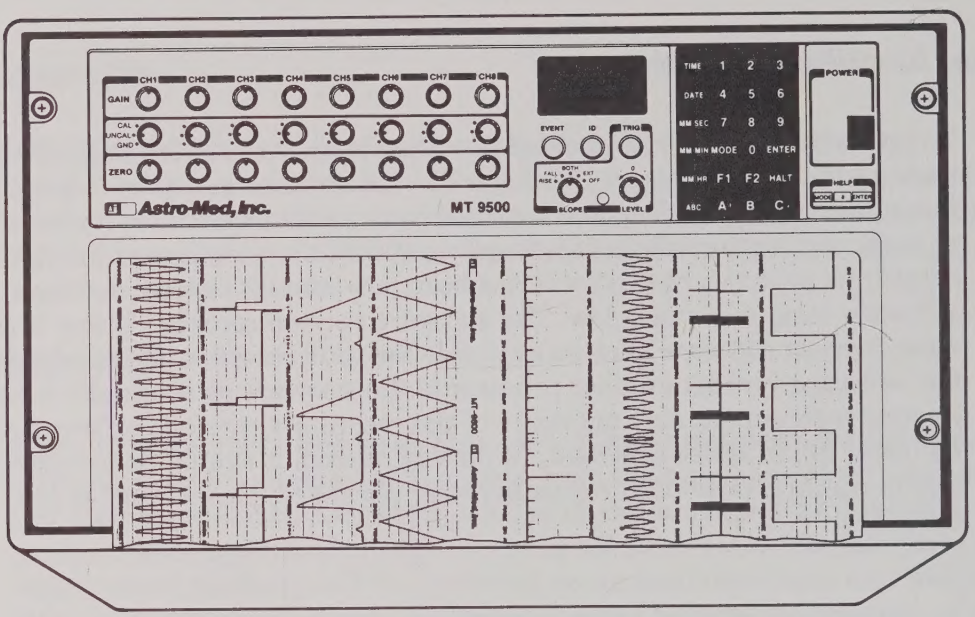
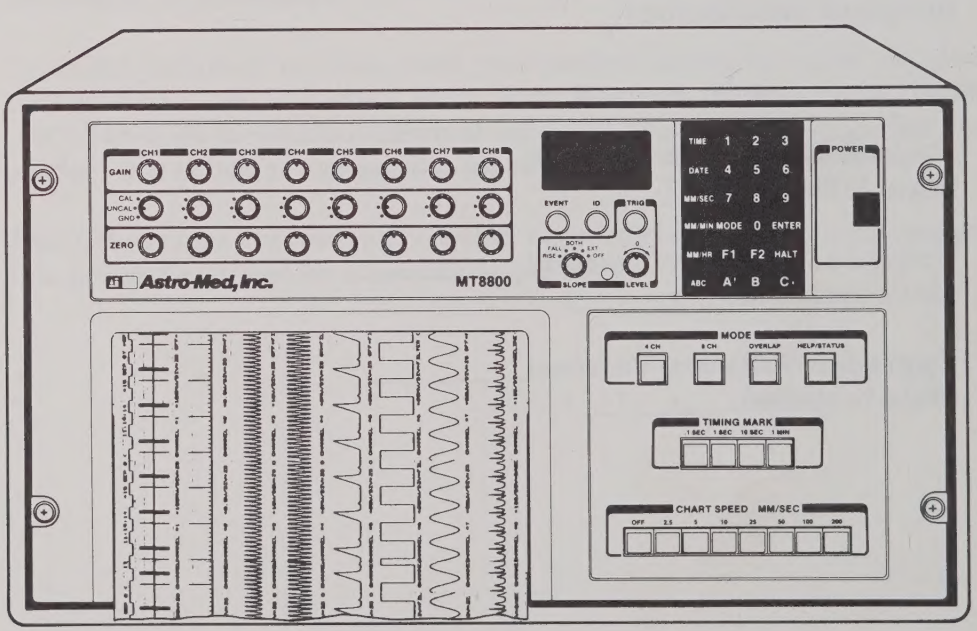


Astro-Med's MT-9500 Recorder



Astro-Med's MT-8800 Recorder

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Section1
Introduction to Host-Control Operations

This manual provides instruction on operating the MT-9500 recorder, the MT-8800 recorder, and the MT-9000 recorder under the control of a host computer. In those cases in which operational procedures differ between the three recorders, separate procedural instructions are provided and clearly identified. For ease of reference throughout this manual, the term "recorder" refers to any of the recorders. You should be aware that the three recorders are separate devices and that the combined terminolgy in the manual is used solely for convenience. In addition, when the term "host control" is used, it indicates the phrase "host-computer control."

MT-9500, MT-8800, and MT-9000 recorders and their full range of functions can be controlled by a host computer using the detailed procedures presented in Section 3 of this manual. All the commands and codes discussed in this manual are designed to be placed into software control programs. Typically, a control program interacts with the operator and the recorder. Codes are transferred from the host computer which may, in response, receive codes from the recorder.

This manual details:

- Entering the recorder into host-computer control
- Modes of operation and commands available under host-computer control
- Exiting host-computer control and returning the recorder to standalone operation

Host control of the recorder can be established through either an RS-232 link or a GPIB link.

The procedures for uploading captured data from the recorder to the host computer and for downloading data from the host computer to the recorder require a GPIB (IEEE-488) link to optimize data transfer. To establish GPIB communications between the host computer and your recorder, connect a standard IEEE cable from the appropriate host-computer output to the 25-pin IEEE PORT on the rear panel of the recorder.

Use cabling between the output connectors of the host computer and the 25-pin SERIAL PORT of the recorder to establish Serial (RS-232) communications between the machines.

Figure 1-1 illustrates typical hardware connections between a recorder and a host computer. Detailed pin-connection data for both the GPIB and RS-232 interfaces is provided in section 2, paragraph 2-1.

When your recorder has been properly connected and prepared for operation, either:

- press the [MODE] [8] [ENTER] keying sequence of the MT-9500 or MT-9000 recorder or
- press the [MODE] [9] [ENTER] keying sequence of the MT-8800 or
- press the HELP/STATUS pushbutton on the lower keypad of the MT-8800.

The recorder will immediately print a "Condensed Operations Manual" for your use. The "Condensed Operations Manual" presents a concise guide to recorder functions. It also lists each optional feature and its status as present in your particular recorder.

Use the "Condensed Operations Manual" to identify the optional features installed in your recorder. Verify that you have received all of the features that you ordered. Figure 1-2 is a sample "Condensed Operations Manual" for an MT-8800 recorder equipped with all optional features. When you are operating your recorder, remember to use only those optional features installed in your unit. As discussed in paragraph 1-2, the recorder will perform only those functions present in its individual software package. Appendix A lists the factory-installed options available for the MT-9500 recorder. Appendix B lists the factory-installed options pertinent to the MT-8800 and the MT-9000 recorders.

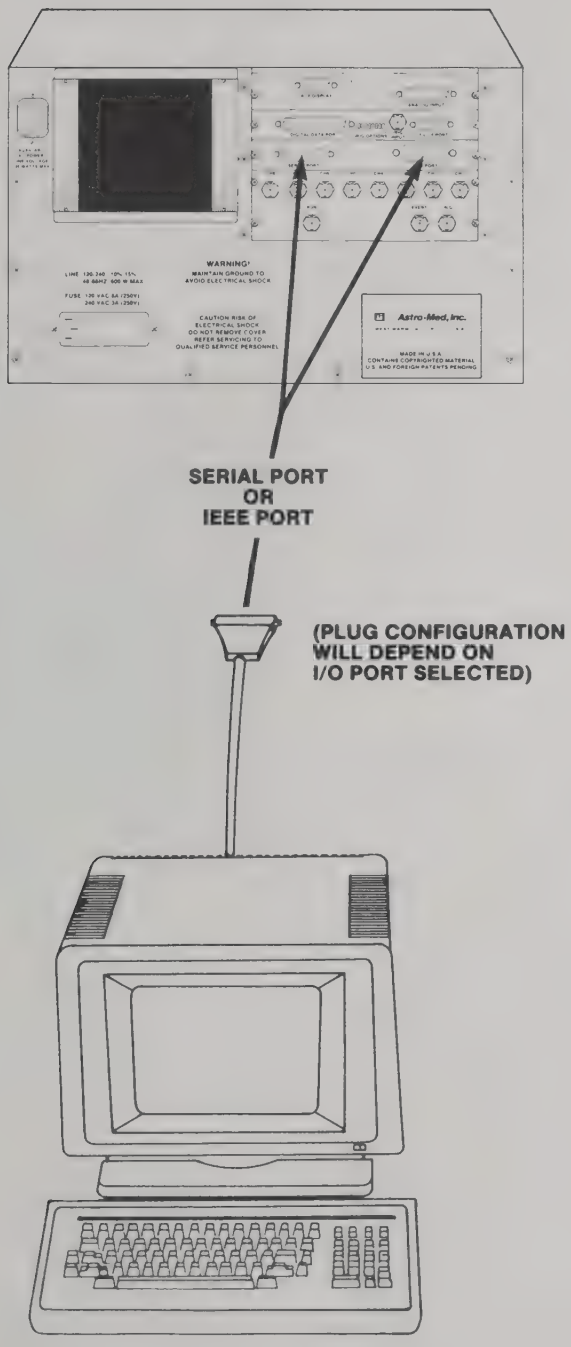

Figure 1-1. Typical Connections: Host Computer to Recorder

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MT-8800 CONDENSED OPERATIONS MANUAL

(Refer to your manual for complete instructions)

OPERATION DESIRED:	HOW TO ACTIVATE:	NOW PROGRAMMED:
1. REAL TIME MODES		
8 CHANNEL REAL TIME RECORDER	[MODE] [0] [ENTER]	-----
4 CHANNEL REAL TIME RECORDER	[MODE] [1] [ENTER]	-----
OVERLAP REAL TIME RECORDER	[MODE] [2] [ENTER]	-----
DUAL SPEED OPERATION*	[MODE] [5] [ENTER]	OFF TIME 1:00:05 SPD 1:025 MM/S TIME 2:00:05 SPD 2:050 MM/S
2. REAL TIME SET UPS:		
TIME	[TIME] [HH MM] [ENTER]	1=:05:01
DATE	[DATE] [MM DD YY] [ENTER]	16/21/88
SPEED	[MM/Y] [X] [ENTER]	025 MM/S
INSTA-SPEED BUTTONS	[ABC] [MM/Y] [X] [ENTER]	A=001 MM/S B=025 MM/S C=050 MM/S
TIMED OPERATION*	[F2] [3] [ENTER]	OFF
EVENT OR ANNOTATION	[F1] [2] [ENTER]	AAAAAAAA
ANNOTATION ENTRY*	[F2] [0] [ENTER]	See next page
SIGNAL CONDITIONER PRINT STATUS	[F2] [8] [ENTER]	NNNNNNNN
GRID PRINTING ON/OFF	[F1] [1] [ENTER]	ON
CHANNEL ORDER SET	[F1] [0] [ENTER]	12345678
SIGNAL POLARITY REVERSE	[F1] [7] [ENTER]	NNNNNNNN

****

OPERATION GUIDELINES:

HALT KEY

Besides starting and stopping the MT-8800, the [HALT] key is used as an ESCAPE key when programming various modes and set ups. If you get "stuck" in any menu, simply press [HALT] to escape.

MISCELLANEOUS

* Several functions offer a number of choices. To see them, press either the [A] or [C] keys. When the format you want appears in the display, press [ENTER]. Modes or functions that require the [A] or [C] key are marked on this sheet with an (*) asterisk.

Several of the functions listed are optional. If an option is not ordered, the MT-8800 will display "NOT USED" for functions related to the option.

Figure 1-2. Sample MT-8800 Condensed Operations Manual

```
OPERATION DESIRED:                          HOW TO ACTIVATE:          NOW PROGRAMMED:
------------------                          ----------------          ---------------

3. DATA CAPTURE MODES

   AQUIRE SINGLE SNAPSHOT.............[MODE][6][ENTER]              -----
   PLAYBACK SINGLE SNAPSHOT...........[MODE][7][ENTER]              -----
   CONTINUOUS SNAPSHOT (untriggered)...[MODE][3][ENTER]              -----
   CONTINUOUS SNAPSHOT (triggered).....[MODE][4][ENTER]              -----

4. DATA CAPTURE SET UPS:

   ACQUISITION*.......................[F1][6][ENTER]              CHANNELS: 8
                                                                   WINDOW: 08 K/CH
                                                                   TMEBSE:001MS/MM
   PLAYBACK*..........................[F1][4][ENTER]              FORMAT: 8-CHNLS
                                                                   START AT:00%
                                                                   EXPANSION:01X
   TRIGGER CHANNEL AND LOCATION*......[F1][3][ENTER]              TRIGGER ON: CH 1
                                                                   WINDOW:START
   TRIGGER ON/OFF.....................[F2][4][ENTER]              ON
   X AND Y CHANNEL SELECT.............[F1][5][ENTER]              X=1
                                                                   Y=2

5. EXTERNAL CONTROL FUNCTIONS:

   LOCAL OR HOST CONTROL SET*.........[F2][6][ENTER]              LOCAL

6. OPTIONS INSTALLED IN THIS RECORDER:
   AP-88    DC-88
   RD-88    EM-88
   IRIG     OM-95
            DI-488-88
*******************************************************************************

ANNOTATION GUIDELINES:
----------------------

Text annotation is entered by first pressing [F2][ENTER].  Now enter the
channel number (1-8),[ENTER].  The display now contains this message: 00 67 C.
This means you are looking at location 00, at which there is an ASCII code 67,
which is an upper case "C".  To step through the buffer, press [C] to
advance, or [A] to reverse.  To jump quickly to a location, press [ABC]
then the location [00-99],[ENTER].  When editing is completed, press [ENTER].
If you edit the middle of a word or sentence, press [HALT] to escape, since
pressing [ENTER] erases anything to the right of what is in the display.

The ASCII codes supported by local text entry are as follows: (x) indicates
character not shown on display.

32    (space)    45    -        58    : (x)    71    G        84    T
33    ! (x)      46    .        59    ; (x)    72    H        85    U
34    "          47    /        60    < (x)    73    I        86    V
35    # (x)      48    0        61    =        74    J        87    W
36    $          49    1        62    > (x)    75    K        88    X
37    %          50    2        63    ?        76    L        89    Y
38    &          51    3        64    @        77    M        90    Z
39    '          52    4        65    A        78    N        91    [
40    ( (x)      53    5        66    B        79    O        92    \ (x)
41    ) (x)      54    6        67    C        80    P        93    ]
42    *          55    7        68    D        81    Q        94    ^ (x)
43    +          56    8        69    E        82    R        95    _
44    ,          57    9        70    F        83    S
```

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Figure 1-2. Sample MT-8800 Condensed Operations Manual (continued)

1-1 General Operation

Just as with standalone operation, host-computer control of the recorder is implemented through the use modes. Modes provide the recorder with specific operational capabilities. Modes are the highest level of the software system. They give the system great flexibility and permit a wide variety of applications. The modes of operation available within host control are listed, defined, and discussed in Section 3, "Modes of Operation."

1-2 Control-Code Sequences

Modes are activated by transmission of ESCAPE (ESC) sequences consisting of two bytes in the generic format: <ASCII> (hexadecimal, hexadecimal). To accomplish a formfeed, for example, the host computer sends an <ESC> F (1BH, 46H). Only a single mode of operation can be active at any given time. Table 1-1 lists the ESCAPE sequences for entering host-control modes. In this manual, the terms "control-code sequence" and "ESCAPE sequence" mean the same thing.

When the recorder has been entered into a mode, the host computer can control the recorder by a subset of control codes. Most modes have control functions that permit speed control of recording, skipping to next line, exiting (aborting) the mode, etc. As each mode of operation is discussed in this manual, the control codes associated with the mode are presented. Additionally, appendix D is provided for quick reference to the control codes for host-control recorder operation.

Host-controlled operation is characterized by extensive "handshaking" between the recorder and host computer. This means that, in many data transactions between host computer and recorder, either standard acknowledgement bytes or standard error bytes are exchanged. Return responses are one-byte codes: 11H or 05H. Code 11H indicates that the command was correctly processed. Code 05H indicates an error.

Do not confuse the hexadecimal code (05H) with the "05" error code that may appear on your recorder's LED display after recorder power-up. "05" is not a hexadecimal code. When necessary, it is displayed by the recorder to indicate an interlock error.

Table 1-1 ESCAPE Sequences for Entering Host-Control Modes

Each ESCAPE code consists of a series of two characters sent to the recorder. The first character is 1BH. It is followed by one of the letters defined below.

code	meaning
@	reserved
A	reserved
B	rotated line printer mode
C	reserved
D	Display and set date
E	Display and set time
F	Formfeed
G*	Digital data recorder modes (synchronized)
H	Calibrate mode
I*	Digital data recorder modes (unsynchronized)
J	reserved
K	Plotter mode
L	reserved
M*	Snapshot (Acquisition) mode
N*	Playback mode
O	reserved
P	Normal line/page print mode
Q	reserved
R	Analog real-time recorder mode
S	Compressed screen print mode
T*	In MT-9500 recorder operation: Datalogger listing mode
T	In MT-8800 recorder operation: reserved
U*	Upload data from recorder to host
V*	Download data from host to recorder
W	reserved
X	reserved
Y	reserved
Z	Setup mode

*Denotes a mode requiring installation of an MT-9500 option.

Throughout this manual, a capital letter H following a code means "hexadecimal. " Table 1-3 lists the equivalencies between ASCII codes and Hexadecimal codes.

Some of the modes and control codes described in this manual require the installation of specified options. Unless the specified option has been installed, you should avoid programming optional functions. A general-purpose error byte of 05H is passed internally between the recorder and host computer in those cases when (1) a user-requested option is not resident in the recorder software, (2) control-code sequences are out of range, or (3) transmission errors occur between host and recorder.

1-3 Error Codes on Recorder Wake-Up

Error codes may appear on the recorder LED display immediately after power has been applied to the instrument. These "error codes on wake-up" are defined in table 1-2.

Table 1-2 Recorder Error Codes On Wake-Up

Error Code*	Description	Possible Cause**
01	Keypad CPU cannot communicate with main CPU	Bad I/O board or CPU board
02	Read/write error while testing main memory	Bad CPU board
03	CPU board error	Bad CPU board
04	I/O board error	Bad I/O board
05	Interlock error	No paper. Door open. Sensor problem.
06	Master controller error	Bad master controller or related cable
07	Slave Controller error	Bad slave or related cable
08	A/D board error	Bad A/D board
No display or erroneous display	Keypad CPU failed to wakeup	Bad I/O board or power problem

*These are not hexadecimal codes. They appear on the recorder's LED only as a result of error conditions after recorder power-up.

**This column highlights sources of error that are most frequently encountered. Sources of error other than those listed may exist.

Table 1-3 ASCII Code / Hexadecimal Code Equivalencies

Hexadecimal Character	ASCII Character	Hexadecimal Character	ASCII Character
00		20	SP (space)
01		21	!
02		22	"
03		23	#
04		24	S
05		25	%
06		26	&
07		27	'
08		28	(
09		29	)
0A	LF	2A	*
0B		2B	+
0C	FF	2C	,
OD	CR	2D	-
0E		2E	.
0F		2F	/
10		30	0
11		31	1
12		32	2
13		33	3
14		34	4
15		35	5
16		36	6
17		37	7
18		38	8
19		39	9
1A		3A	:
1B	ESC	3B	;
1C		3C	<
1D		3D	=
1E		3E	>
1F		3F	?

Table 1-3 ASCII Code / Hexadecimal Code Equivalencies (continued)

Hexadecimal Character	ASCII Character	Hexadecimal Character	ASCII Character
40	@	60	
41	A	61	a
42	B	62	b
43	C	63	c
44	D	64	d
45	E	65	e
46	F	66	f
47	G	67	g
48	H	68	h
49	I	69	i
4A	J	6A	j
4B	K	6B	k
4C	L	6C	l
4D	M	6D	m
4E	N	6E	n
4F	O	6F	o
50	P	70	p
51	Q	71	q
52	R	72	r
53	S	73	s
54	T	74	t
55	U	75	u
56	V	76	v
57	W	77	w
58	X	78	x
59	Y	79	y
5A	Z	7A	z
5B	[	7B	{
5C	\	7C	|
5D	]	7D	}
5E	^	7E	~
5F	_		7F

Section 2
Entering Host-Control Operation

Follow the procedure given below to initiate host-computer control of your recorder. Recorders can be connected in series (daisy-chained or star configured) to a host computer using their IEEE-488 (GPIB) interfaces. The number of recorders that can be operated in this way is dependent on the capabilities of the host-computer controller bus.

When either the RS232 or GPIB communication interface is selected, only the [F2] key is functional. This key will allow you to enter the command to return to stand-alone operation.

1. **Connect the recorder to the host computer through either the Serial (RS-232) port or the IEEE-488 (GPIB) rear-panel data port.**

2. **Press the [F2] key on the keypad.**

3. **Press the [6] key.**

   The display reads <SET COMM>.

4. **Press the [ENTER] key.**

   The display reads <KEYPAD>.

5. **Either press the [ENTER] key to accept the keypad or press the [A] Key to view the other two choices (GPIB or RS-232) and then press the [ENTER] key to make your selection.**

6. **If you chose the keypad, the display will read <WAIT> while it returns to stand-alone operation and <READY> when the communication is set. <READY> indicates that this sequence is over. If you chose RS-232, go to step 7. If you chose GPIB (IEEE), go to step 8.**

7. **The display illuminates the last-entered baud rate (BR 300, BR 1200, BR 9600, or BR 19200). Either press the [ENTER] key to select the current setting or press the A key to view the other three choices. Press the [ENTER] key to make your selection. The display reads <RS-232>. A blinking dot indicates that you have finished this command sequence.**

8. **The display reads <GPIB 05> or the last address entered. Either press the [ENTER] key to accept the current setting and end this command sequence or enter a numerical address from 0 to 31.**

9. **Press the [ENTER] key.**

   The display reads <GPIB> *followed by the address you entered and a blinking dot.*

2-1 RS-232 and GPIB Communication Interfaces

The following tables provide pin-connection data for the recorder's RS-232 and IEEE-488 (GPIB) interfaces.

An application note detailing programming of the IEEE-488 interface is shipped with this manual. As described in the application note, there are two methods for implementing the GPIB interface. Recorders with firmware packages prior to SCN 13.X use the original GPIB implementation procedure. Recorders with firmware packages of 13.X or greater can use either the original procedure or an enhanced GPIB implementation. Enhanced GPIB upgrades the state funtions and their implementation to improve overall system operation.

Pin Connection: IEEE (488)

Description	Pin #	Description	Pin #
DI01	1	DIO5	13
DI02	2	DIO6	14
DI03	3	DIO7	15
DI04	4	DIO8	16
EOI	5	REN	17
DAV	6	GROUND (6)	18
NRFD	7	GROUND (7)	19
NDAC	8	GROUND (8)	20
IFC	9	GROUND (9)	21
SRQ	10	GROUND (10)	22
ATN	11	GROUND (11)	23
SHIELD	12	GROUND LOGIC	24

GROUND (X) = the signal ground return of the referenced

Pin Connection: Serial (RS-232)

Description	Pin #	Source
RXD	2	host
TXD	3	recorder
CTS	4	*
RTS	5	*
DTR	6	recorder
COMMON	7	-
RESERVED	10	-
RESERVED	12	-
RESERVED	13	-
RESERVED	14	-
RESERVED	16	-
DSR	20	host
RESERVED	23	-
RESERVED	24	-

*Pins 4 and 5 are connected internally.

(8 bits, no parity, 2 stop bits)

2-2 Recorder Default Settings

When operating under host-computer control, the recorder will default all functional parameters to preset values. This is done to provide baseline host-control settings for any operation undertaken immediately after gaining control of the recorder. The operator can alter the default settings or set them to fixed values using the host system. A complete list of default settings follows.

Recorder Default Settings

Grid printing	on
Channel order	signal 1 - 8
Acquisition time base	1 ms/mm
Real-time motor speed	25 mm/s
Storage method/window size	8 chan., 8K samples
Window/trigger relationship	start trace
X and Y channels	1 and 2
Playback expansion (recorder modes)	X 1
Trigger	on
Playback percentage	complete
Polarity inversion	polarity not inverted
Motor speed clock source	internal
Acquisition time base clock source	internal
Numeric listing calibration (MT-9500 only)	+200 to -200
Signal conditioner reporting	all off
Interchannel buffers	clear (spaces)
Trigger channel	signal 1

Section 3
Modes of Operation

Just as with standalone operation, host-computer control uses the modes and mode presets of your recorder to accomplish the recording you desire. In fact, controlling the recorder through a host computer provides you not only with the modes available in standalone operation but also with several modes unique to host-control operation. Although this manual provides you with all the information that you require to implement host control, don't hesitate to refer to your recorder's Operations Manual for more information concerning the instrument's modes, presets, and features.

Remember that options are required for certain modes. This manual clearly identifies all modes that require options.

The information in this manual is arranged so that the recorder's presets are discussed before modes of operation are explained. This is logical because presets influence modes and their resulting output. The modes used to set the recorder's clock and calendar are discussed first because they determine the time and date that appear on the system log and serve as a reference point for all time/date data. Next, the setups of the Setup mode are discussed. Last, full discussions of the recorder's modes are presented. Table 3-1 lists and defines the recorders' modes of operation.

Table 3-1 Modes of Operation

Mode	Description
Display and Set the Current Date	Analyzes current date stored in recorder and, if necessary, changes it
Display and Set the Current Time	Analyzes current time stored in recorder and, if necessary, changes it
Setup	Allows definition of sixteen recording presets that influence the format of recorded data
Analog Real-Time Recording	Allows the recording of analog waveform data in real-time in a variety of formats
Synchronized Digital Data Recording	Allows the transfer of digital data from the host computer to the recorder with synchronous rate of data transfer and printing speed
Unsynchronized Digital Data Recording	Allows the transfer of digital data from the host computer to the recorder with unsynchronous rate of data transfer and printing speed
Data Capture	Allows the capture of 128k sample data points for playback or transmission to host computer for storage or analysis
Playback	Allows playback of captured data in a variety of formats
Formfeed	Advances chart paper to next page (top-of-form)
Datalogger	Allows playout of real-time analog waveform data as numeric lists of user-specified engineering units

Table 3-1 Modes of Operation (continued)

Mode	Description
Upload Captured Data	Allows transmission of captured waveform data to host computer for storage or analysis
Download Data from Host Computer	Allows transmission of waveform data from host computer to recorder
MT-9500 Line/Page Printer	Allows the MT-9500 to operate as line printer or page printer with numerous capabilities
MT-8800/9000 Line Printer	Allows the recorder to operate as a line printer
MT-9500 Compressed Printer	Allows the MT-9500 recorder to compress characters and so enable printing of graphic representations
MT-8800/9000 Compressed Printer	Allows the recorder to compress characters and so enable printing of graphic representations
Calibrate	Allows the host computer to receive raw data sampled from the recorder's analog-to-digital converters
Plotter	Permits the MT-9500 to operate as a high resolution plotter that produces a variety of graphic representations, plots, and diagrams
Rotated Line Printer	Allows the recorder to print annotation comments in the same direction as the eight waveforms

As noted earlier, the recorder's modes are entered through use of ESCAPE sequences transmitted from the host computer. Entry into some modes requires additional codes to complete the ESCAPE sequence. Modes can be exited either by host-computer command or by automatic action of the recorder. After modes are exited, code 01H is always transmitted to the host. 01H indicates that the ongoing mode has been completed and that the recorder is ready to accept a new mode ESCAPE sequence.

The sections that follow discuss in detail each mode, its associated control codes, and applicable responses. Modes that require installation of an option are clearly noted.

3-1 Display and Set the Current Date

This mode allows the host computer system to analyze the current date stored in the recorder and, if necessary, change it.

Command: Display and Set the Date

1. Send <ESC> D (1BH, 44H) to initiate action.

2. Wait for a group of ASCII characters to come from the recorder. The response code is either:

IRIG <CR> (0DH)	if IRIG timing is used
dd mmm yy <CR> (0DH)	for the day, month (Jan, Feb, etc.), and year of the manually entered time

3. Reply with the appropriate ASCII code:

<CR> (0DH)	if the date is correct
<CR> (0DH)	if IRIG is used
mm?dd?yy<CR> (0DH)	to change the date ? is any character mm is the numeric month Leading zeros must be used to fill blanks

4. Wait for a byte to come from the recorder and compare it to the following:

05H	Error byte. Retransmit the date.
11	Byte accepted. Command executed.

5. The recorder sends a 01H to the host to verify that it is at command level.

Example: Set the Current Date

From Host	From Recorder	Description
1. <ESC> D (1BH, 44H)		Enters mode.
2.	07 May 98	Current date.
3. 05/08/98 <CR> (0DH)		Changes date.
4.	11H	Acknowledges change.
5.	01H	Acknowledges exit.

3-2 Display and Set the Current Time

This mode allows the host computer system to analyze the current time stored in the recorder and, if necessary, change it.

Command: Display and Set the Time

1. Send <ESC> E (1BH, 45H) to initiate action.

2. Wait for a group of ASCII characters to come from the recorder. The response code is either:

jjj:hh:mm:ss.t <CR> (0DH)	for the Julian date, hours (in 24-hour format), minutes, seconds, and tenths of seconds if IRIG timing is used
*hh:mm:ss <CR> (0DH)	for the hours (in 24-hour format), minutes, and seconds of the manually-entered time

**Four blank spaces (20H) will precede the 24-hour format*

3. Reply with the appropriate ASCII code from the following list:

<CR> (0DH)	if the time is correct
<CR> (0DH)	if IRIG is used
hh?mm <CR> (0DH)	to change the time Seconds are automatically reset. ? is any character Leading zeros must fill blanks

4. Wait for a byte from the recorder and compare it to:

05H	Error byte. Retransmit the byte.
11H	Byte accepted. Command executed.

5. The recorder sends a 01H to the host to verify that it is at command level.

Example: Set the Current Time

From Host	From Recorder	Description
1. <ESC> E (1BH, 45H)		Enters mode.
2.	12:10:51	Current time.
3. 12:20 <CR> (0DH)		Changes time.
4.	11H	Acknowledges change.
5.	01H	Acknowledges exit.

3-3 Formfeed the Chart Paper

The Formfeed mode advances the chart paper to the top of the next page (top-of-form). If the chart paper is already at top-of-form, the paper will advance one page. Refer to your recorder's Operations manual to ensure that the Astro-Med thermal sensitive chart paper is properly loaded in the recorder's paper chamber.

Command: Formfeed the Chart Paper

1. Send <ESC> F (1BH, 46H) to initiate action.

2. The recorder will advance the paper, return to the command level, and transmit a 01H to the host.

3-4 Setup Mode

The recorder Setup mode is of great importance. Most data-capture parameter settings are defined and most of the resulting playbacks are formatted in the Setup mode. When the recorder is operating in the Setup mode, the host computer can alter some or all of the settings. No recorder output results from activity occuring in the Setup mode. The setups of the Setup mode are listed in table 3-2. Some setups cannot be altered unless the appropriate option has been installed in the recorder.The control-code sequences associated with each setup are presented in the subparagraphs that follow.

When the recorder is returned to local operation, the settings remain as last established by the host computer.

Command: Enter the Setup Mode

1. Send an <ESC> Z (1BH, 5AH) to initiate action.

2. The recorder transmits 11H to inform host that the Setup mode has been entered.

3. Host can transmit control code sequences as described in the following sections.

Table 3-2 Setups of the Setup Mode

Setup	Definition
Selecting From Grid Printing Options	Suppresses or re-initiates grid printing and selects grid format from the options available
Selecting the Order of the Recorder Channels	Establishes the order of the channels on the chart paper as viewed from the recorders front
Defining the Time Base for Data Capture	Establishes the time base for a data capture
Defining the Storage Method/ Window Size Relationship	Determines the number of sample points captured per channel
Defining the Window/Trigger Relationship	Establishes the relationship between a trigger and the corresponding data that is captured
Selecting Two Channels for an X-Y Plot	Permits selection of two channels to be plotted as an X-Y graph
Print Either Annotation or Event Markers in Interchannel Buffers	Permits selection of either alphanumeric annotation or event marker lines to be printed in the recorder's interchannel buffers
Expand Captured Data Upon Playback	Allows captured data to be expanded upon playback

Table 3-2 Setups of the Setup Mode (continued)

Setup	Definition
Trigger Disable	Disables any triggers occuring in either real-time or data-capture modes
Selecting the Data Capture Sample-Rate Source	Allows selection of either an internal or external source for controlling the sample rate of a data capture
Define the Trigger Channel	Allows selection of a trigger channel
Selecting the Percentage of Captured Data to be Played Back	Permits selection of the starting point of a data capture playback and so defines the percentage of data to be deleted from the playback
Inverting the Polarity of a Signal	Allows polarity of individual channels to be inverted
Selecting the Motor-Speed Clock Source	Allows selection of either an internal or external source of control for motor stepping rate
Enabling or Disabling the "Talking" Signal Conditioner Feature	Permits enabling or disabling of status reportfor each signal conditoner
Numeric Listing Calibration (MT-9500 only)	Enables playout in numeric tabular lists of either real-time data or data-capture playback

3-4.1 Selecting from Grid Printing Options

The host computer can either suppress or re-initiate grid printing. The host computer can also select from the grid pattern choices listed below.

Command: Initiate or Suppress MT-9500 Grid Printing

1. Send 01H to initiate action.

2. Send one byte to specify grid status:

+ (2BH)	turns the grid on
- (2DH)	turns the grid off

3. Wait for a byte to come from the recorder. Compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

Command: Initiate or Suppress MT-8800/9000 Grid Printing / Specify Grid Choice

1. Send 01H to initiate action.

2. Send one byte to specify grid status:

+ (2BH)	turns the grid on
- (2DH)	turns the grid off

3. Send an additional byte to specify grid type. Terminate the byte with a carriage return.

1 <CR> (31H, 0DH)	Grid 1
2 <CR> (32H, 0DH)	Grid 2
3 <CR> (33H, 0DH)	Grid 3
4 <CR> (34H, 0DH)	Grid 4
5 <CR> (35H, 0DH)	Grid 5

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.2 Selecting the Order of the Recorder Channels

Channels 1 through 8 default to printing in ascending order from left to right as viewed from the front of the recorder. This command enables you to change that order.

Command: Set the Order of the Recording Channels

1. Send 02H to initiate action.

2. Enter 8 channel numbers (ASCII, 31H - 38H), in the order the channels are to be displayed. Conclude with a <CR> (0DH).

3. Wait for a byte to come from the recorder. Compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.3 Defining the Time Base for Data Capture

The recorder requires the DC-95 option to perform any data-capture actions.

The snapshot time base determines the resolution of the waveform. As with an oscilloscope, resolution is based on time over distance (ms/mm). You can choose time bases from 1 to 100 milliseconds per millimeter. However, the best time resolution is obtained when the smallest time base is used. After all, 100 milliseconds of data would need to be more tightly compacted to fit into a 1 millimeter increment than would 1 millisecond of data.The time base also determines the amount of time that snapshot data are captured. The smallest time base (1) produces the shortest sampling time and the longest time base (100) produces the longest.

Command: Define the Time Base for Data Capture

1. Send 03H to initiate action.

2. Send a digit from 1 - 100, in ASCII form, to determine the snapshot time base.

3. Send a carriage return (0DH)

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.4 Defining the Storage Method / Window Size Relationship

The recorder requires the DC-95 option to perform any data-capture actions.

The size of the snapshot window determines the number of sample points captured per channel. The recorder can gather a maximum of 128,000 sample points of snapshot data. This equals 16,000 sample points per channel for eight channels of data (128,000/8) and 64,000 sample points per channel for two channels of data (128,000/2). Sample points are specified in kilosamples and are set in increments of 1,000. This means that you can determine the number of sample points collected for each channel by entering a number from 1 to 16 for eight channels of data and 1 to 64 for two channels of data. Because the same kilosample setting applies to all of the channels, you would set the window to 5 kilosamples if you wanted to collect 5,000 samples points for each channel.

The size of the snapshot window determines the amount of paper used. Your recorder steps paper 16 times per millimeter. You can determine the amount of paper (in millimeters) to be used by dividing the size of the snapshot window by 16.

Command: Define Storage Method/Window Size Relationship

1. Send a 04H to initiate action.

2. Send one of the following digits to determine the number of analog channels captured.

   MT-9500 only

2 (32H)	2 user-designated X-Y channels are captured (1 - 65 kilosamples)

8 (38H)	8 channels are captured (1 - 16 kilosamples)

3. Send a one or two ASCII digit sequence to determine the window size in kilosamples. Conclude with a carriage return (0DH).

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.5 Defining the Window/Trigger Relationship

The recorder requires the DC-95 option to perform any data-capture actions.

The trigger-to-window relationship determines the relationship of the trigger to its corresponding data. While the system is awaiting a trigger, snapshot data are constantly being sampled and swept through a circular buffer system. This means that new data are always entering one side of the buffer while the same amount of data are exiting the buffer system. If your window size is set to 16,000 samples, the 16,000 most recently captured sample points are within a buffer for each channel at all times. Therefore, you can predetermine the trigger position in relation to its data. Your choices are Start, Center, and End.

If you want to save the trigger followed by 16,000 sample points, you should preset the trigger relationship to Start.

Positioning the trigger relationship to the Center causes the recorder to capture 8,000 sample points. This action is followed by the trigger and 8,000 more sample points.

An End trigger-to-window relationship provides you with 16,000 sample points followed by a trigger.

Command: Define the Window/Trigger Relationship

1. Send 05H to initiate action.

2. Send an ASCII digit or sequence of digits and terminate it with a carriage return to define the condition of the signal.

1 <CR> (31H, 0DH)	start
2 <CR> (32H, 0DH)	center
3 <CR> (33H, 0DH)	end
4 , byte 1, byte 2, <CR> (34H, 0DH)	percentage: byte 1 and byte 2 form a two-digit sequence that specifies a trigger point as a percentage of the window*

**0% = start trace. 100% = end trace. The two bytes specify a percentage. This percentage equals the amount of pre-trigger information that will be stored in the buffer during a snapshot. To calculate the amount of post-trigger information stored in the buffer: 100% - pre-trigger data = post-trigger data.*

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.6 Selecting Two Channels for an X - Y Plot

The recorder requires the DC-95 option to perform any data-capture actions.

The recorder is capable of producing X-Y plots of two captured signals. The channel-choice function allows the user to specify which channel will be X and which will be Y when plotted on a 160mm plot. When two-channel data capture is selected, the X-Y choices have an additional function: they specify the two channels to be captured on the next acquisition.

Command: Select Two Channels for an X - Y Plot

1. Send 06H to initiate action.

2. Enter two codes specifying X and Y channel choices. Valid codes are 1-8 (31H-38H).

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.7 Print Either Annotation or Event Markers in Interchannel Buffers

Either alphanumeric annotation or event marker lines can be printed within each channel's associated interchannel buffer.The MT-9500 recorder requires the AP-95 and EM-95 options to perform these functions. Use the procedure below to determine whether each channel buffer will contain an event marker line or alphanumeric annotation.

Command: Print Annotation Event Marker Lines

1. Send 07H to initiate action.

2. Send up to eight codes and a carriage return (0DH) to determine whether an event or annotation line is printed for each channel. The first digit sent corresponds to the channel printed on the left-most position on the chart paper, and so on, as viewed from the front of the recorder.

0 (30H)	annotation line
1 (31H)	event line

for example, to define 4 left-most interchannel areas as annotation and 4 right-most interchannel areas as event markers:
07H, 31H, 31H, 31H, 31H, 30H, 30H, 30H, 30H, 0DH

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.8 Expand Captured Data Upon Playback

The recorder requires the DC-95 option to perform any data-capture actions.

This command offers you the ability to expand captured data when you play that data back. You can expand the data to a maximum expansion factor of 25. An expansion factor of 1 causes the recorder to print the data as recorded. Setting the expansion factor within the range of 2 to 25 stretches the waveform by the factor chosen. Stretching the waveform is particularly useful when studying small details.

Because the time required to print a playback increases proportionately with the expansion factor, you may wish to eliminate any unneeded data at the beginning of a plot by altering the starting point of the playback (0CH).

Command: Expand Captured Data on Playback

1. Send 08H to initiate action.

2. Send a two-digit ASCII sequence and conclude with a carriage return (0DH) to set the expansion factor within a range of 1 - 25. Leading zeros are required.

3. Wait for a byte from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted Command executed.

3-4.9 Disable All Triggers

This command can be used to disable any triggers that occur in either a real-time or data-capture mode. This function overrides the front panel control "OFF." This means that even manual triggers are not allowed.

Command: Disable All Triggers

1. Send 09H to initiate action.

2. Send one byte from the following list and a carriage return (0DH) to enable or disable the triggers.

+ <CR> (2BH, 0DH)	enable triggers
- <CR> (2DH, 0DH)	disable triggers

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1
11H	Byte accepted. Command executed.

This command is useful when setting the trigger slope on the front panel of the recorder. If you want to determine the voltage level required to produce a trigger and you don't want to waste recording paper in the process, you can disable the trigger. When the trigger is disabled, you can adjust the level switch and monitor the trigger lamp without actually producing a trigger. The lamp will illuminate on detection of a trigger.

3-4.10 Selecting the Data Capture Sample-Rate Source

The recorder requires the DC-95 option to perform any data-capture actions.

This control function allows you to change the sample rate from internal to external control during data capture. External frequency can be from 0 - 8000Hz.

To Select an External Data Capture Sample-Rate Source

1. Connect an external clock to the TTL UTILITY PORT on the rear panel of the recorder. Pin 15 (sample clock input) of the TTL UTILITY PORT is used to establish this connection. The complete TTL UTILITY PORT pin-connection table is provided below.

2. Choose an EXTERNAL sample rate source.

Pin Connection: TTL Utility Port

Description	Pin #
/SYSTEM EVENT	1
/EVENT 1 (channel 1)	2
/EVENT 2 (channel 2)	3
/EVENT 3 (channel 3)	4
/EVENT 4 (channel 4)	5
/EVENT 5 (channel 5)	6
/EVENT 6 (channel 6)	7
/EVENT 7 (channel 7)	8
/EVENT 8 (channel 8)	9
REMOTE START/STOP	10
RESERVED	11
EXTERNAL TRIGGER	12
GROUND	13
RESERVED	14
SAMPLE CLOCK (optional)	15

To Select an Internal Data-Capture Sample-Rate Source

Choose an INTERNAL stepper clock source.

Command: Select an Internal or External Data Capture Sample-Rate Source

1. Send 0AH to initiate action.

2. Send one byte from the following list and a carriage return (0DH) to select either an internal or external stepper rate source.

0 <CR> (30H, 0DH)	internal source
1 <CR> (31H, 0DH)	external source

Example: Change to external sampling frequency /exit Setup mode.
Host transmission: 0AH, 31H, 0DH, 18H

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1
11H	Byte accepted. Command executed.

3-4.11 Define the Trigger Channel

This command allows the host computer to select a channel that will be the triggering channel. The trigger-channel parameter will be active only if the trigger source has been set to an input signal by the front panel.

Following a 4BH, the host computer must send an ASCII digit from 1-8 (31H - 38H) and a carriage return (0DH). This will complete the command sequence. An invalid entry will not change the status of the trigger channel.

Command: Define the Trigger Channel

1. Send 0BH to initiate action.

2. Enter the hex equivalent of one channel from 1-8 (31H-38H) and terminate it with a carriage return (0DH) to choose the trigger channel.

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1
11H	Byte accepted. Command executed.

3-4.12 Selecting the Percentage of Captured Data To Be Played Back

The recorder requires the DC-95 option to perform any data-capture actions.

This control function allows you to alter the starting point of your playback and so control the amount of data played back. This is done by entering a number from 1 to 99 to represent the percentage of data you wish to delete from the playback. Playback data are deleted only from the beginning of the buffer. For example, setting the playback to 25% would cause your unit to print the last 75% of the data . This command alters the starting point of the playback but not the buffer itself. You can reset this command to provide additional playback formats.

Command: Select the Percentage of Captured Data To Be Played Back

1. Send 0CH to initiate action.

2. Transmit a sequence of ASCII digits representing a number from 1 - 99 and terminate it with a carriage return (0DH) to choose the percentage of captured data to be deleted from the playback.

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1
11H	Byte accepted. Command executed.

3-4.13 Inverting the Polarity of a Signal

In recording modes, the recorder has a signal polarity-inversion capability that permits polarity inversion on independent channels. If selected, polarity inversion is functional during real-time recorder modes and during playback. The user can playback data with any or all of the signals inverted.

Command: Invert the Polarity of a Signal

1. Send 0EH to initiate action.

2. Send eight ASCII digits and terminate them with a carriage return (0DH) to define the condition of the signal. The first digit sent corresponds with the channel printed on the left-most position on the chart paper, and so on, as viewed from the front of the recorder.

0 (30H)	normal
1 (31H)	inverted

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.14 Selecting the Motor-Speed Clock Source

The recorder requires the RD-95 option to have this capability.

You can use this option (in conjunction with the UTILITY PORT on the rear panel of your recorder) to control the motor stepper rate from an external source when your recorder is operating in a real-time, waveform-producing mode. Normally, the stepper rate is calculated in the main microprocessor and is based on time (the speed you select to record the incoming waveform). This feature allows you to step the motor at your own discretion. This enables you to change the base on which the motor stepper rate is founded. You can, for example, step the motor based on distance.

The motor may be stepped to a maximum of 800 hertz (50 mm/s).

To Select External Motor-Speed Clock Source

1. Connect an external clock to the TTL UTILITY PORT on the rear panel of the recorder. Pin 15 (sample clock input) of the TTL UTILITY PORT is used to establish this connection. The complete TTL UTILITY PORT pin-connection table is provided on page 3-18 of this manual.

2. Choose an EXTERNAL stepper clock source.

To Select Internal Motor-Speed Clock Source

Choose an INTERNAL stepper clock source.

Command: Select an External or Internal Motor Speed Clock Source

Set this command to tell the recorder whether it should look for stepper control from an external clock or generate stepper control internally.

1. Send a 0FH to initiate action.

2. Send one ASCII digit from the following list to determine the sourceof the motor speed.

   1 (31H) internal (self-generated)
   2 (32H) external (by clock)

3. Send a <CR> (0DH) to terminate this command.

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1
11H	Byte accepted. Command executed.

3-4.15 Playout Data in Numeric Listing Format

The numeric listing format capability is available only on MT-9500 recorders equipped with the Datalogger (DL-95) option.

The MT-9500 can produce recorded information not only in traditional analog waveform formats but also in tabular numeric formats. The numeric listing format is available both in real-time operation and during data-capture playback. Use this feature if you want your real-time analog waveform data played out in numeric format. Also, use this command as a preset to the Datalogger mode.

This command enables you to define the calibration units for both the right and left edges of a waveform. When the calibration units are set, the MT-9500 automatically calculates all input values for the waveform based on these units. If the calibration units for a particular waveform are not set, the MT-9500 automatically sets the right edge of the waveform to -200 and left edge to +200 with an exponent of 0.

for example,

To adjust an incoming waveform so its left edge is -20° C and its right edge is +150° C you should set the left edge to -0200 and its right side to +1500. Entering a four-digit number enables the MT-9500 to use the best resolution attainable. The exponent should be -1.

Command: Playout Data In Numeric Listing Format

1. Send a 10H to initiate action.

2. Send the ASCII equivalent of the channel (1 - 8) you wish to calibrate.

3. Send a four-digit ASCII string to define the left side of the channel.

4. Send one byte to determine the polarity of the left side of the channel.

+ (2BH)	positive
- (2DH)	negative

5. Send a four-digit ASCII string to define the right side of the channel.

6. Send one byte to determine the polarity of the right side of the channel.

+ (2BH)	positive
- (2DH)	negative

7. Send one ASCII digit (0-4 or 30H-34H) to define the exponent.

8. Send one byte and a carriage return (0DH) to determine the exponent polarity. This sign is required even if the exponent is zero. The sign will simply be ignored.

+ <CR> (2BH, 0DH)	positive
- <CR> (2DH, 0DH)	negative

9. Wait for a byte to come from the MT-9500 and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

Example

From Host	From MT-9500
1. 0H	
2. 31H	
3. 30H, 35H,30H, 30H	
4. 2BH	
5. 30H, 35H,30H, 30H	
6. 2DH	
7. 0H	
8. 2BH	
9. 0DH	
10.	11H

3-4.16 Enabling or Disabling the "Talking" Signal Conditioner Feature

The MT-9500 recorder requires the AP-95 option to perform this function.

If you have a C-950 Card Cage (the rear panel of which has a 37-pin D-shell for status report), signal conditioners from the 900 series, *and the channel-annotation (AP-95) option,* the "Talking" signal conditioner feature allows your system to print a status report for each signal conditioner. The status report provides detailed interchannel annotations consisting of 40 characters that indicate signal-conditioner operating status. These reports are printed within the last 40 characters of each of the signal conditioner's corresponding channel labels.

Because the status report uses the last 40 buffer spaces, it may override the last part of the channel label. However, the status report does not alter the information in the channel-annotation buffer. It temporarily masks it. When you have disabled the status reporting feature, the channel label reads as entered by the channel-annotation command.

Command: Enable or Disable Signal Conditioner Status Reporting

1. Send 11H to initiate action.

2. Enable or disable signal conditioner reporting for selected channels by sending a maximum of eight codes and a carriage return (0DH). The first digit sent corresponds with the channel printed on the left-most position on the chart paper, and so on, as you view it from the front of the recorder. Valid codes are: 0 (30H), 1 (31H).

   Example: 11H, 30H, 31H, 33H, 0DH

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

3-4.17 Exiting the Setup Mode

This code causes the recorder to exit the Setup mode and returns the recorder to the command level.

Command: Exit the Setup mode

1. Send 18H to initiate action.

2. The recorder terminates the mode and sends a 01H to the host.

3-5 Accessing Recorder Operational Commands

When the recorder is operating in either the Analog Real-Time Recorder mode, the Synchronized Digital Data Recorder mode, or the Unsynchronized Digital Data Recorder mode, many operational commands can be implemented from the host computer. Operational commands control numerous aspects of what appears on the printed chart. Table 3-3 lists and briefly defines the operational commands.

Some of these commands are not common to all three modes. The cases in which an operational command applies only to a specific operating mode are clearly noted.

Paragraphs 3-5.1 through 3-5.3 tell you how to instruct the host computer to enter the recorder into the Analog Real-Time Recorder mode, the Synchronized Digital Data Recorder mode, or the Unsynchronized Digital Data Recorder mode, respectively. After you have entered any of these modes, the host computer can utilize the operational commands listed in table 3-3.

Paragraphs 3-6 through 3-6.12 detail the functions of the operational commands and the command sequences required to initiate them.

To repeat, the operational commands discussed in paragraphs 3-6.1 through 3-6.12 are only available when the recorder is functioning in either the Analog Real-Time Recorder mode, the Synchronous Digital Data Recorder mode, or the Unsynchronous Digital Data Recorder mode. Enter any of the three modes using the "enter the mode" command sequences that follow.

Table 3-3 Operational Commands

Command	Definition
System Log Channel On/Off	Turns the system log channel on or off
System Event/Trigger Marker Lines On/Off	Causes the system event/trigger marker lines to be either printer or suppressed
Event Marker Lines On/Off	Determines whether or not an event marker line will be printed within an interchannel buffer
Print Channel ID on Waveform	Causes recorder to print a channel ID number once on each waveform
Deflecting the System Event Marker Line	Causes the system event marker line to rise and fall to mark data of interest
New Motor Speed (SCN 1X.X)	Used to change the motor speed of Phase I MT-9500 recorders and MT-8800/9000 recorders when operating in either the Analog Real-Time Recorder mode or the Unsynchronized Digital Data Recorder mode
Deflecting the Interchannel Event Marker Lines	Causes the interchannel event marker lines to rise and fall to mark data of interest

Table 3-3 Operational Commands (continued)

Command	Definition
New Motor Speed (SCN 2X.X)	Used to change the motor speed of Phase II MT-9500 recorders and MT-8800/9000 recorders when operating in either the Analog Real-Time Recorder mode or the Unsynchronized Digital Data Recorder mode
Channel Labels: Print Once	Causes immediate, one-time printing of channel labels
Channel Labels: Start Printing Repeatedly	Causes immediate, continuous printing of channel labels
Channel Labels: Stop Printing Repeatedly	Immediately causes printing of channel labels to cease
Real-Time Recording: Start/Stop	Starts or stops the recorder during real-time analog operation
Channel Label: Edit Line or Character	Permits editing of either a line of interchannel alphanumeric content or an individual character in any one of the channel labels

3-5.1 Entering the Analog Real-Time Recorder Mode

Before entering this mode, you may want to enter the Setup Mode and alter any system parameters that you desire changed.

Command: Enter the Analog Real-Time Recorder Mode

1. Send an <ESC> R (1BH, 52H) to initiate action.

2. **For MT-9500 recorder operation**, send one of the following bytes to choose the recording format:

8 (38H)	Eight 40-mm channels containing one waveform each
2 (32H)*	Two 160-mm channels with four overlapping waveforms each

3. **For MT-8800/9000 recorder operation**, send one of the following bytes to choose the recording format:

8 (38H)	Eight 20mm channels containing one waveform each
4 (34H)	Four 40mm channels containing one waveform each
2 (32H)*	One 160mm channel with eight overlapping waveforms

   ***with option only**

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Retransmit your byte.
11H	Byte accepted. Mode entered.

The Analog Real-Time Recorder mode has seven default conditions that are activated every time the mode is entered:

- the operation is halted
- the motor speed is set to 25 mm/s
- the system log channel is enabled
- the system event/trigger marker is enabled
- the buffers for the eight interchannel-annotation lines are clear
- the eight interchannel annotation lines are not printed
- the printing of the eight interchannel event markers is enabled

After you have entered the Analog Real-Time Recording mode, the operational commands of table 3-3 become available. Many of these commands are identical to commands available in the Synchronized Digital Data Recorder mode and the Unsynchronized Digital Data Recorder mode. To eliminate redundancy, commands common to these three modes are described in paragrah 3-6, "Operational Commands." After you have entered the Analog Real-Time Recorder mode, proceed to "Operational Commands" to work within the mode. Follow the instructions in paragraph 3-7 to exit the mode.

3-5.2 Entering the Synchronized Digital Data Recorder Mode

The recorder requires the Digital Interface option (DI-488-95) to possess the Synchronized Digital Data Recorder mode.

During host control, operation in the Synchronized Digital-Data Recorder mode permits you to perform two broad categories of action:

- intiate the operational commands listed in paragraphs 3-6.1 through 3-6.12

- download digital data from the host to the recorder through a GPIB link

Use the command sequence given below to enter the the Synchronized Digital Data mode. When you have entered the mode, proceed to paragraphs 3-6.1 through 3.6.12 to implement operational commands. Proceed to paragraph 3-18 to format and download synchronized digital data from the host to the recorder.

Command: Enter the Synchronized Digital Data Mode

1. Send an <ESC> G (1BH, 47H) to initiate action.

2. **For MT-9500 recorder operation**, send one byte to choose the appropriate playback format:

1 (31H)	eight 40-millimeter channels
2 (32H)*	two 160-millimeter channels containing four waveforms each
3 (33H)	thirty-two channels

3. **For MT-8800/MT-9000 recorder operation**, send one byte to choose the appropriate playback format:

1 (31H)	eight 20-millimeter channels
2 (32H)*	one 160-millimeter channel containing eight waveforms
3 (33H)	not used
4 (34H)	four 40-millimeter channels

***with option only**

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Retransmit your byte.
11H	Byte accepted. Recorder waits for data

After you have entered the Synchronized Digital Data Recorder mode, the operational commands of table 3-3 become available. Many of these commands are identical to commands availble in the Analog Real-Time Recorder mode and the Unsynchronized Digital Data Recorder mode. To eliminate redundancy, commands common to these three modes are described in paragrah 3-6, "Operational Commands".

Go to paragraph 3-6, "Operational Commands," to implement operational commands while working in the Synchronized Digital Data mode.

Follow the instructions in paragraph 3-9 to exit the mode.

Go to paragraph 3-18 to format synchronized digital-data packets for transmission from the host computer to the recorder.

3-5.3 Entering the Unsynchronized Digital-Data Recorder Mode

The recorder requires the Digital Interface option (DI-488-95) to possess the Unsynchronized Digital Data Recorder mode.

During host control, operation in the Unsynchronized Digital-Data Recorder mode permits you to perform two broad categories of action:

- initiate the operational commands listed in paragraphs 3-6.1 through 3-6.12
- transfer digital data from the host to the recorder through a GPIB link

Use the command sequence given below to enter the the Unsynchronized Digital Data mode. When you have entered the mode, proceed to paragraphs 3-6.1 through 3-6.12 to implement operational commands. Proceed to paragraph 3-18 to format and download synchronized digital data from the host to the recorder.

Command: Enter the Unsynchronized Digital-Data Mode

1. Send an <ESC> I (1BH, 49H) to initiate action.
2. **For MT-9500 recorder operation**, send one byte from the following listto choose the appropriate playback format:

1 (31H)	eight 40-millimeter channels
2 (32H)	two 160-millimeter channels containing four waveforms each
3 (33H)	thirty-two channels

3. **For MT-8800/9000 recorder operation**, send one byte from the following list to choose the appropriate playback format:

1 (31H)	eight 20-millimeter channels
2 (32H)	one 160-millimeter channel containing eight waveforms
3 (33H)	not used
4 (34H)	four 40-millimeter channels

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Retransmit your byte.
11H	Byte accepted. Recorder waits for data and control packets.

After you have entered the Unsynchronized Digital Data Recorder Mode, the operational commands of table 3-3 become available. Many of these commands are identical to commands available in the Analog Real-Time Recorder Mode and the Synchronized Digital Data Recorder Mode. To eliminate redundancy, commands common to these three modes are described in paragrah 3-6, "Operational Commands".

Go to paragraph 3-6, "Operational Commands," to implement operational commands while working in the Unsynchronized Digital Data mode.

Go to paragraph 3-18 to format unsynchronized digital-data packets for transmission from the host computer to the recorder.

Follow the instructions in paragraph 3-9 to exit the mode.

3-6 Operational Commands

With a few exceptions, the commands listed below are common to the Analog Real-Time Recorder mode, the Synchronized Digital Data Recorder mode, and the Unsynchronized Digital Data Recorder mode. Commands that are not shared by all three of these modes are clearly identified.

NOTE

If you will be working in either the Unsynchronized Digital Data mode or the Synchronized Digital Data mode, you need to format the operational commands listed below as control packets. The control packet format consists of:

- an ASCII C header
- the command you wish to implement
- an EOI indicating the end of the control packet

3-6.1 System Log Channel On/Off

This command turns the system log channel on or off.

Command: Turn the System Log Channel On/Off

1. Send 03H to initiate action.
2. Send one byte:

+ (2BH)	enables the system log channel
- (2DH)	disables the system log channel

3-6.2 System Event/Trigger Marker Lines On/Off

This command causes the system event/trigger marker lines to be either printed or suppressed. See paragraph 3-6.5, "Deflecting the System Event Marker Line to Mark Data" for directions on use of the system event/trigger marker lines.

Command: Turn the System Event/Trigger Marker Line On/Off

1. Send 05H to initiate action.

2. Send one byte:

   + (2BH) enables the printing of this marker
   - (2DH) disables the printing of this marker

3-6.3 Event Marker Lines On/Off

In order to have the event marker lines on/off capability, the recorder requires installation of the Event Marker option (EM-95).

This command allows you to determine whether or not an event marker will be printed within any given interchannel buffer. The event marker lines are controlled by data packets and deflect to the left to mark data of interest.

Command: Turn Event Marker Lines On/Off

1. Send 06H to initiate action.

2. Send the hex equivalent of one number from 1-8 (31H-38H) to choose the channel event to be altered.

3. Send one byte from the following list and terminate it with a carriage return (0DH):

   + <CR> (2BH, 0DH) turns the channel event on
   - <CR> (2DH, 0DH) turns the channel event off

3-6.4 Print Channel ID on Waveform

This command causes the recorder to print a channel ID number on each of the waveforms one time. This capability is used most commonly to distinguish signals during waveform-overlap operation.

Command: Print a Channel ID Number on Waveform

Send O9H to accomplish this action.

3-6.5 Deflecting the System Event Marker Line to Mark Data

In normal operation, deflection of the system event marker line is controlled by transistor/transistor logic (TTL) levels through a BNC connector or by the front-panel pushbutton EVENT switch. The 0CH command gives you additional software control over the system event marker line.

When the system event marker line is inactive (low), it is printed as a straight line to the immediate right of the system log channel. As soon as you begin to mark an event, the event line becomes active and and rises to the left (high).

Any device, software command, TTL level, or pushbutton switch can be used to toggle the system event marker line from low to high. However, only the method used to toggle the system event marker line to the high position may be used to return the system event marker line to its low position.

Send 0CH to toggle the sysetm event marker line to active or inactive states.

3-6.6 New Motor Speed

The new motor speed commands listed below apply only to the Analog Real-Time Recorder mode and the Unsynchronized Digital Data Recorder mode .

When in the Analog Real-Time Recorder mode and the Unsynchronized Digital Data Recorder mode, you can change the recorder's motor speed by sending the one of the two 0EH sequences given below. Send the sequence presented in paragraph 3-6.6.1 below for Phase I MT-9500 recorders. Upon power-up, Phase I recorders display a software configuration number of SCN 1X.X. Send the sequence presented in paragraph 3-6.6.2 below for Phase II MT-9500 recorders. Upon power-up, Phase II recorders display a software configuration number of SCN 2X.X. The speed word must be calculated. See "Computing the Speed Word" on the following page.

Computing the Speed Word

The formula used to compute the speed word is:

(1/16) (1/speed) (1 MHz) = # units

for example,

25 millimeters per second:

(1/16) (1/25) (1,000,000) = 2,500 (09C4H) units. Range = 1

Speed Word Examples

Speed	Number of Units		Range
1.0 mm/hr	62,500	(F424H)	3
10.0 mm/hr	6,250	(186AH)	3
50.0 mm/hr	1,250	(04E2H)	3
1.0 mm/min	62,500	(F42H)	2
10.0 mm/min	6,250	(186AH)	2
25.0 mm/min	2,500	(09C4H)	2
50.0 mm/min	1,250	(04E2H)	2
1.0 mm/s	62,500	(F424H)	1
2.5 mm/s	25,000	(61A8H)	1
10.0 mm/s	6,250	(186AH)	1
25.0 mm/s	2,500	(09C4H)	1
50.0 mm/s	1,250	(04E2H)	1
100.0 mm/s	625	(0271H)	

During external motor speed operation, the commands will not change the motor speed.

A method for making Phase I recorders accept the new motor speed sequence of Phase II recorders is provided at the end of paragraph 3-8.6.1.

Both sequences require five bytes. The first four bytes constitute the ASCII code of the hex value of the speed word. The speed word must be calculated. The speed word represents the operating speed of the recorder desired by the user.

3-6.6.1 New Motor Speed (recorders with SCN 1X.X)

This command applies only to the Analog Real-Time Recorder mode and the Unsynchronized Digital Data Recorder mode.

Use the sequence below to change the motor speed of Phase I MT-9500 recorders.

Command: Change Motor Speed of Phase I MT-9500

1. Send 0EH to initiate action.

2. Send four ASCII bytes to equal the hex value of the speed word in the following order:

   - MSD of the post-divider word (ASCII)
   - 2nd MSD of the post-divider word (ASCII)
   - 3rd MSD of the post-divider word (ASCII)
   - LSD of the post-divider word (ASCII)

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Retransmit the speed.
11H	Byte accepted. Proceed.

4. Send the one code for the range word from the list below*:

31H	mm/second
32H	mm/minute
33H	mm/hour

   **Any others are undefined.*

5. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Retransmit the range.
11H	Byte accepted. Command executed.

Setting the recorder's rear-panel DIP switch #7 to the ON position (up) allows the Phase I machine to accept the Phase II speed sequence. The Phase II speed sequence in presented in paragraph 3-6.6.2.

3-6.6.2 New Motor Speed (recorders with SCN 2X.X). *This command applies only to the Analog Real-Time Recorder mode and the Unsynchronized Digital Data Recorder mode.*

Use the sequence below to change the motor speed of Phase II MT-9500 recorders.

Command: Change Motor Speed of Phase II MT-9500

1. Send 0EH to initiate action.
2. Send three ASCII bytes (31H - 39H) that correspond to the desired three digit speed.
3. Send one ASCII byte (31H - 33H) representing a choice of range:

   31H = mm/sec 32H = mm/min 33H = mm/hr

4. End the sequence with a carriage return (0DH).
5. Wait for a byte from the MT-9500

05H	Error byte. Retransmit the range.
11H	Byte accepted. Command executed.

3-6.7 Deflecting the Interchannel Event Marker Lines to Mark Data

The interchannel event-marker deflection command is available only in the Analog Real-Time Recorder mode.

In order to have the interchannel event marker level deflection capability, the recorder requires installation of the Event Marker option (EM-95).

In normal operation, either the recorder's front-panel TRIG pushbutton or TTL levels input through the rear-panel TTL UTILITY PORT are used to deflect interchannel event marker lines to the left and so mark data of interest. This command allows you to control the deflection (rise) and fall of interchannel event marker lines via software command.

When the interchannel event marker lines are low, they are inactive, i.e., they appear as straight lines. However, as soon as you begin to mark an event, the event lines become active and rise to the left.

Although software commands, TTL levels, or the front-panel manual TRIG pushbutton can be used to toggle the interchannel event marker lines from low to high, only the method used to toggle the event marker lines to the high (left deflected) position can be used to return them to the low (flat line) position.

Command: Deflect the Interchannel Event Marker Lines

1. Send 0FH to initiate action.

2. Send up to eight ASCII digits (31H - 38H) followed by a carriage return (0DH) to toggle the interchannel events 1 - 8 into an active or inactive state.

3-6.8 Channel Labels: Print Once

This command results in the immediate printing of channels labels. The labels are printed once rather than repeatedly. See paragraph 3-6.9 below to direct the recorder to print channel labels repeatedly.

Command: Print Channel Labels Once

Send 10H* to cause an immediate, single printing of channel labels.

**If the recorder has been commanded to print the channel labels continuously (15H), this command (10H) will supersede the previously sent command.*

3-6.9 Channel Labels: Start Printing Repeatedly

The recorder requires the AP-95 option to possess this capability.

This command results in the immediate and continuous printing of channel labels.

Command: Print Channel Labels Repeatedly

Send 15H to cause immediate, continuous printing of channel labels.

3-6.10 Channel Labels: Stop Printing Repeatedly

The recorder requires the AP-95 option to possess this capability.

This command causes the recorder to stop the continuous printing of channel labels.

Command: Stop Printing Channel Labels Repeatedly

Send 16H to cause the recorder to stop the continuous printing of channel labels.

3-6.11 Real-Time Recording: Start/Stop

This command is only available in the Analog Real-Time Recorder mode.

This command allows you to start or stop the recorder during real-time analog operation.

Command: Start or Stop Real-Time Recording

Send 13H to start or stop real-time recording.

3-6.12 Channel Label: Edit Line or Character

The recorder requires the AP-95 option to possess this capability.

A channel label can be thought of as a string of characters from 1 to 100. Each character has an assigned value that determines what will be printed. This command enables you to edit either a line of interchannel content or an individual character in any one of the channel labels. Both actions are described below.

Command: Edit Line in a Channel Label

1. Send 17H to initiate action.

2. Enter the hex equivalent of one channel from 1-8 (31H-38H) to choose the channel label to be edited.

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Retransmit your byte
11H	Byte accepted. Proceed.

4. Send up to 100 ASCII characters between 20H and and 7FH. All other characters are ignored.

5. Send one byte to terminate the entry unless the entry is exactly 100 characters:

<CR> (0DH)	If the new data is shorter than the old data, the remainder of the buffer will be cleared when the recorder receives the carriage return (0DH). A single carriage return is a fast way to clear the buffer.
0BH	The byte will terminate the command without altering the data remaining in the buffer.

6. Wait for the recorder to respond with an 11H to signify that the command is finished.

Example: Edit Line

Current channel 4 label reads:ENGINE #4 Thrust Per Square Inch.
You are monitoring a tail rotor and would like to edit the channel label.

TAIL VIBRATION IN G'S

From Host	From Recorder	Description
1. 17H		Enters command.
2. 34H		Chooses channel label (4).
3.	11H	Acknowledges choice.
4. 54H,61H, 69H, 6CH, 20H,56H, 69H 62H, 72H,61H, 74H, 69H, 6FH,6EH, 20H, 49H, 6EH,20H, 47H, 27H, 73H 2EH		
8. <CR> (0DH)		Terminates command; remaining buffer is erased.
9.	11H	Acknowledges exit.

Command: Edit Character In a Channel Label

You can send a 1CH and two additional ASCII characters to edit a paticular character within the buffer.

1. Send 17H to initiate action.

2. Enter the hex equivalent of one channel from 1-8 (31H-38H) to choose the channel label to be edited.

3. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Retransmit your byte.
11H	Byte accepted. Proceed.

4. Send a 1CH.

5. Send two ASCII bytes from 30H - 39H to represent the position of the chosen character. Leading zeros are required.

   Because the 100th character consists of three numbers but the recorder is designed to accept only two numbers, send 00 (30H, 30H) for 100.

6. Wait for a byte to come from the recorder and compare it to the following:

05H	Error byte. Repeat from step 1
11H	Byte accepted. Cursor at appropriate buffer point.

7. Send a maximum of 100 ASCII characters between 20H and 7FH to edit the label. All other characters are ignored.

8. Unless the entry is exactly 100 characters, send one byte from the following list to terminate the entry.

<CR> (0DH)	If the new data is shorter than the old data, the remainder of the buffer will be cleared when the recorder receives the carriage return (0DH). A single carriage return is a fast way to clear the buffer.
0BH	The byte will terminate the command without altering the data remaining in the buffer.

9. Wait for the recorder to respond with an 11H signifying that the command is finished.

Example
The current label for channel 2 reads:
CHANNEL 2: Pressure Main Turbo Valve (RD-29).

You are monitoring turbo valve RD-38 and would like to edit the channel label to read: CHANNEL 2: Pressure Main Turbo Valve (RD-38).

Example: Edit Character

From Host		From Recorder	Description
1.	17H		Enters command.
2.	32H		Chooses channel label (2).
3.		11H	Acknowledges choice.
4.	1CH		Begins character edit.
5.	34H, 33H		Chooses character position (43).
6.		11H	Acknowledges character position.
7.	33H, 38H		Value of character 43 becomes 3. Value of character 44 becomes 8.
8.	0BH		Terminates command; remaining buffer is unaltered.
9.		11H	Acknowledges exit.

3-7 Exiting the Analog Real-Time / Synchronized Digital Data / or Unsychronized Digital Data Recorder Modes

You entered either the Analog Real-Time Recorder mode, the Synchronized Digital Data Recorder mode, or the Unsynchronized Digital Data Recorder mode to record in the mode and to use the operational commands shared by these three modes as detailed in paragraphs 3-6.1 through 3-6.12.

Use the following host-control command to return the recorder to the command level from either the Analog Real-Time Recorder mode, the Synchronized Digital Data Recorder mode, or the Unsynchronized Digital Data Recorder mode.

Command: Exit the Mode

1. Send 18H to initiate action.

2. Wait for the recorder to stop all action and send 01H to acknowledge that the recorder has successfully reached the command level.

3-8 Data Capture Mode

The recorder requires the DC-95 option to perform any data-capture actions.

This mode enables the recorder to capture and store 128,000 sample points of data in its buffer. When captured, this data can be either printed in a playback or transmitted to the host for storage or analysis. Because this mode captures data according to the acquisition parameters determined within the Setup mode (03H, 04H, 05H, 06H, 09H, and 0BH), you should set these parameters while in the Setup mode.

Command: Perform a Data Capture

1. Send an <ESC> M (1BH, 4DH) to initiate action.

   If the trigger has been disabled, the recorder will begin to capture data immediately after this mode has been entered. If the trigger is enabled, the recorder will wait for a trigger before it captures the data.

2. After the data is captured, the recorder will exit the mode and send a 01H to the host.

You can abort this acquisition sequence at any time prior to the completion of the snapshot by sending an 18H. When sent, the recorder will exit the mode as detailed in step 2. The information captured before this sequence was aborted remains valid and can be used in a playback or a data transference.

In actual operation, any transmission sent from the host to the recorder during a data-capture sequence will abort the Data Capture mode.

3-9 Playback Mode

The recorder requires the DC-95 option to playback data.

The Playback mode initiates printing of a hard copy of captured data in accordance with the playback parameters determined within the Setup mode (08H, 0CH, and 10H). You should establish the desired setup parameters while in the Setup mode.

Command: Perform a Data Capture Playback

1. Send an <ESC> N (1BH, 4EH) to initiate action.

2. **For MT-9500 recorder operation**, send one byte from the following listto choose the appropriate playback format:

   1 (31H) eight 40-millimeter channels

   2 (32H) two 160-millimeter channels containing four waveforms each (OM-95 option required)

   3 (33H) X-Y plot

   4 (34H) tabular numeric print

3. **For MT-8800/9000 recorder operation**, send one byte from the following list to choose the appropriate playback format:

   1 (31H) eight 20-millimeter channels

   2 (32H) one 160-millimeter channel containing eight waveforms (OM-95 option required)

   3 (33H) X-Y plot

   4 (34H) not used

   5 (35H) four 40-millimeter channels

4. Wait for a byte to come from the recorder and compare it to:

05H	Error byte. Retransmit your byte
11H	Byte accepted.

5. When the playback is complete, the recorder will exit the mode and send a 01H to the host.

When you have entered the Playback mode, you can use the operational commands detailed in paragraphs 3-6.1 through 3-6.12. To implement operational commands, send a CTRL-S after entering the Playback mode and send the desired operational command sequences.

You can abort this acquisition sequence at any time prior to the completion of the playback by sending an 18H. When sent, the recorder will exit the mode as detailed in step 4.

3-10 Uploading Captured Data From the Recorder to the Host

The recorder requires the DC-95 option to perform any data-capture actions.

As with recorder operation under local control, host control permits the recorder to transmit all waveform data captured during an acquisition. This is a valuable tool for data storage and analysis. This feature is optional and can only be accessed through a GPIB communication link. The waveform data are stored in unscaled form in accordance with the window-size acquired. Data from captured channels will be transmitted to the host as requested by the host.

The recorder stores analog waveform information in special max/min packets for each sample period acquired. To playback data properly in recorder modes, the data should be processed in max/min packets. To accommodate users who wish to work only in single-point format, an averaged waveform packet is also available.

To enter the recorder into an upload sequence, the host computer sends the recorder an <ESC> U (1BH, 55H) followed immediately by a data format code 1 (31H) or 2 (32H). Code 1 causes the recorder to transfer data to the host in max/min form. Code 2 causes the recorder average the max/min values for a sample period and transfer that single point.

After receiving the format code, the recorder transmits a confirmation code of either 11H or 05H. If a 05H was received, the host will retransmit the format code (valid 31H or 32H). If 11H was sent, the recorder successfully entered the mode.

The recorder will continue to the next step. This step consists of transmitting to the host the number of channels to be sent and the window size of the snapshot stored in memory. The number of channels will be an ASCII digit of either 2 (32H) or 8 (38H). The window value represents the number of sample periods that have been acquired and should be expected from the recorder. Window size will be in ASCII form (2 bytes). If a window size of 00 (30H, 30H) was received, no data reside in memory and no data will be transferred from the recorder.

Valid window sizes will be in the range of 1-16 or 1-65 depending on the number of channels captured. If the recorder has informed the host that no acquired data resides in memory, the recorder will self-exit the mode. The recorder will transfer to the host a 01H representing that the main command level is ready for a new mode.

After the window size has been accepted, the host can either exit by command 18H or request that transmission begin by command 13H. Regardless of the chosen format, data will be transferred in low-byte/high-byte format and will be in the range of 0-2047 (0-7FFH). A value of FFFFH also may be sent. FFFFH represents a memory point in the window region that was not a true sampled point. These points will be present during an upload if a snapshot was aborted prior to completion or if the trigger occurred at a rate that did not allow capture of all pre-trigger points.

3-10.1 Uploading Captured Data in Max/Min Format

When commanded to begin transmission, the recorder will transmit waveform information for signal 1 in max/min format. Each data point consists of 4 bytes (2 max / 2 min). The recorder will transmit window-size number of points to the host computer with an EOI attached to the last byte. This last byte will be a high byte of the min word. The recorder will then transmit a one byte checksum code with an EOI attached. The checksum checks for errors. If the checksum is incorrect, the host returns a 05H and the data-stream is retransmitted. If correct, the host sends an 11H. The recorder then begins sending data for the next channel. This process continues for each channel. The host can abort at any time by sending an 18H command to the recorder. The checksum is calculated by adding each byte of waveform data transmitted..

3-10.2 Uploading Captured Data in Single-Point Averaged Format

If you lack the max/min format capability but can use an averaged representation of a signal, you can choose a single-point averaged format. Data are sent in single-point, low-byte/high-byte format ranging from 0-2047. This type of transmission takes half of the amount of transfers of the max/min format. After receiving the 13H command from the host, the recorder will send a number of window-sized samples to the host computer. An EOI will be attached to the last byte followed by a checksum with an EOI. A confirmation code of 05H or 11H must be sent from the host to validate the transfer.

When all eight channels have been sent or when an 18H has been sent to terminate the transfers, the system will exit the routine. The recorder will send the host a 01H to signal that it is ready for the next mode.

3-11 Downloading Data From the Host Computer to the Recorder

The recorder requires the DC-95 option to perform any data-capture actions.

As with recorder operation under local control, host control permits the recorder to accept waveform data from the host computer. This data may have been uploaded from the recorder or acquired from another source. This capability is useful for recording digital data in recorder format. This feature is optional and can only be accessed when a GPIB communications link has been established. This mode is most commonly used when other digital recording modes are not satisfactory or when the host desires to transmit large blocks of data to free the system while the recorder is recording data in the playback mode.

The recorder has the ability to store data in two formats. Data transferred from the host computer is stored in the max/min format. The recorder can store a maximum of 16 kilosamples of data per channel. The host should send digital waveform data in the range of 0-07FFH (11 bit data) in an unscaled format. The host can send an out-of-range value of FFFFH if suppression of the sample period is desired. The host computer must send the recorder an <ESC> V (1BH, 56H) to enter the recorder into a download sequence.

This should be followed immediately by a data format code 1 (31H) or code 2 (32H). Code 1 causes the recorder to accept data from the host in max/min form. Code 2 causes the recorder to accept data in point form and to use this point as the maximum and minimum when recording the data.

When the format code has been received, the recorder transmits a confirmation code of either 11H or 05H. If 05H was received, the host computer should retransmit the format code (valid 31H or 32H). If an 11H was sent, the recorder successfully entered the mode. The recorder will continue to the next step: accepting a host-specified number of channels and a host-specified number of data points per channel (window size). The number of channels must be an ASCII digit of either 2 (32H) or 8 (38H). The window size should be sent from the host in two ASCII digits (30H - 39H). Window size ranges from 1 - 16 or from 1 - 65 depending on the number of channels to be stored. After receiving the window size, the recorder sends a confirmation code of 05H or 11H to the host. Code 11H indicates a valid window size. Code 05H indicates that the host should retransmit a valid window size.

After sending the confirmation code, the recorder will await data input in accordance with the selected data format. An EOI should be attached to the last transferred byte. The host should wait for a byte from the recorder confirming transmission. If the code is a 09H, the memory capacity of the recorder has been exceeded. Data received during overflow will be ignored. Data received before overflow are accepted. An 11H code indicates a successful transfer.

After the first confirmation, a second code representing the checksum will be sent. The host should indicate the correctness or incorrectness of the checksum. If the host sent a 05H, the host should retransmit the entire channel of data. If an 11H was sent, the host can continue by sending the next channel of data. The host can send an exit command at this place in the transfer to abort the transmission.

When the specified number of channels has been sent or when an 18H has been received, the system will exit the mode and send a 01H to the host signifying that it is ready for the next command.

3-11.1 Downloading Data in the Max/Min Format

When commanded to begin receiving data from the host computer, the recorder accepts waveform information for channel 1 in max/min format. Each data point consists of 4 bytes (2 max / 2 min). The recorder will accept window-size number of data points from the host computer with an EOI attached to the last byte. The last byte will be the high byte of the min word.

3-11.2 Downloading Data in the Single-Point Averaged Format

If you cannot process the max/min format but can process an averaged signal representation, choose the single-point averaged format. Data are sent in single-point, low-byte/high-byte format ranging from 0-2047. This type of transmission will take one-half of the max/min amount of transfers. The recorder will average the stored max/min values into a single-point value prior to each transmission to the host computer.

3-12 MT-9500 Line/Page Printer Mode

The MT-9500 can operate as a line printer or page printer having the following capabilities:

- Print uppercase and lowercase letters
- 11 characters per inch
- 80 characters per line
- 66 lines per page
- Full ASCII set and IBM graphics set with valid codes 00-FFH excluding a few control characters

To enter the MT-9500 Line/Page Printer mode

1. Send an <ESC> P (1BH, 50H) to initiate action.

2. Host then transmits a 1 (31H) or 2 (32H) for line or page printer:

   1 (31H) Line printer will print 80 character line on half of the recorder (similar to standard line printer)

   2 (32H) Page printer will print output of 2 pages in book format

During this mode, the MT-9500 uses both a full ASCII set and an IBM-PC graphic set with valid codes 00-FFH excluding the following control codes:

(09H) - Horizontal TAB
Causes TAB at eight space increments

(0AH) - Line feed
Advances pointer to new line

(0CH) - Form feed
Advances pointer to new page

(0DH) - Carriage return
Advances pointer to beginning of line

(0BH) - Exit mode
Sole exit method from the LINE PRINT mode

The printer mode accepts an unlimited amount of characters into a buffer to a maximum of an LF or FF. However, no more than the first 80 characters will be printed. After receiving a carriage return (0DH), the recorder returns to the beginning of the same line and overwrites the buffer. An LF or FF identifies completion of a line. In the line printer mode, the line is immediately printed. A formfeed completes the line and positions further output to the beginning of a new page.

At the end of a data block, the condition may occur in which no LF or FF is present to force the printing of the last line of characters. In this case, the recorder waits three or four seconds for new data. If no characters are received, the system will execute a line feed.

The only difference between the line mode and the page mode is that the buffering of data occurs on a line basis as opposed to a page basis. In addition, output occurs on a full-width book format rather than a half-width line basis.

When you want to exit the line printer mode, the host computer should transmit a 0BH. When an EXIT command (0BH) is recieved, a 01H is sent from the recorder to the host computer. The MT-9500 then returns to the main command level to await the next mode.

3-13 MT-8800/9000 Line Printer Mode

The recorder can operate as a line printer that has the following capabilities:

- Print uppercase and lowercase letters
- 11 characters per inch
- 80 characters per line
- 66 lines per page
- Full ASCII set and IBM graphics set with valid codes 00-FFH excluding a few control characters

To enter the MT-8800/9000 Line Printer mode

1. Send an <ESC> P (1BH, 50H) to initiate action.

2. Host then transmits a 1 (31H) for line printer.

   1 (31H) Line printer will print 80 character line on half of the recorder (similar to standard line printer).

During this mode, the recorder uses both a full ASCII set and an IBM-PC graphic set with valid codes 00-FFH excluding the following control codes:

(09H) - Horizontal TAB
Causes TAB at eight space increments

(0AH) - Line feed
Advances pointer to new line

(0CH) - Form feed
Advances pointer to new page

(0DH) - Carriage return
Advances pointer to beginning of line

(0BH) - Exit mode
Sole exit method from the LINE PRINT mode

The printer mode accepts an unlimited amount of characters into a buffer to a maximum of an LF or FF. However, no more than the first 80 characters will be printed. After receiving a carriage return, the recorder returns to the beginning of the same line and overwrites the buffer. An LF or FF identifies completion of a line. In the line printer mode, the line is immediately printed. A formfeed completes the line and positions further output to the beginning of a new page.

At the end of a data block, the condition may occur in which no LF or FF is present to force the printing of the last line of characters. In this case, the recorder waits three or four seconds for new data. If no characters are received, the system will execute a line feed.

When you want to exit the line printer mode, the host computer should transmit a 0BH. Upon receiving an EXIT command (0BH), a 01H is sent from the recorder to the host. The recorder then returns to the main command level to await the next mode.

3-14 MT-9500 Compressed Printer Mode

In general, the compressed printer mode is similar to the line and page printing modes. However, its characters are compressed to enable graphic representations. See your host-computer user manual to determine how to access and file.

To enter the MT-9500 Compressed Printer mode

1. Send an <ESC> S (1BH, 53H) to initiate action.
2. The host transmits a 1 (31H) or 2 (32H) for line or page printer.

1 (31H)	Line printer will print 80 character lines on half of the recorder (similar to standard line printer)
2 (32H)	Page printer will print output of two pages in book format

The following control codes may be used during MT-9500 printing modes:

09H Horizontal Tab
Prints eight spaces

0AH Line Feed
Prints the buffer, fills the buffer with blanks, and advances the paper to the next line.

0CH Form Feed (top-of-form)
Prints the buffer, fills the buffer with blanks, and advances the paper to the next page (top-of-form).

0DH Carriage Return
Returns to the beginning of the buffer and writes over the information contained there.

0BH Exit Mode
The recorder will send an 01H upon exiting the mode.

The buffers accept an unlimited number of characters. However, no more than the first eighty characters can be printed.

Occasionally there may be no line or form feed at the end of a block of data to force the printing of the last line. In this circumstance, the MT-9500 waits three to four seconds for new data. If no new characters are transferred by the end of this period of time, the MT-9500 assumes that the data transfer is finished. The recorder then performs a line feed that causes the last line to be printed.

To exit this mode, the recorder recieves a 0BH from the host computer. Upon receiving an EXIT command (0BH), a 01H is sent from the recorder to the host. The MT-9500 then returns to the main command level to await the next mode.

3-15 MT-8800/9000 Compressed Printer Mode

In general, the compressed printing mode is similar to the line printing mode. However, its characters are compressed to enable graphic representations. See your host-computer user manual to determine how to access and file.

To enter the MT-8800/9000 Compressed Printer mode

1. Send an <ESC> S (1BH, 53H) to initiate action.

2. The host transmits a 1 (31H) for line printer.

   1 (31H) Line printer will print 80 character lines on half of the recorder (similar to standard line printer)

The following control codes may be used when the MT-8800 is functioning within any of the printing modes:

09H Horizontal Tab
Prints eight spaces.

0AH Line Feed
Prints the buffer, fills the buffer with blanks, and advances the paper to the next line.

0CH Form Feed (top-of-form)
Prints the buffer, fills the buffer with blanks, and advances the paper to the next page (top-of-form).

0DH Carriage Return
Returns to the beginning of the buffer and writes over the information contained there.

0BH Exit Mode
The recorder will send an 01H upon exiting the mode.

The buffers accept an unlimited number of characters. However, no more than the first eighty characters can be printed.

Occasionally there may be no line or form feed at the end of a block of data to force the printing of the last line. In this circumstance, the MT-8800 waits three to four seconds for new data. If no new characters are transferred by the end of this period of time, the MT-8800 assumes that the data transfer is finished. The recorder then performs a line feed that causes the last line to be printed.

When the user wants to exit this mode, the host transmits a 0BH. Upon receiving an EXIT command (0BH), a 01H is sent from the recorder to the host. The MT-8800 then returns to the main command level to await the next mode.

3-16 Calibrate Mode

The calibrate mode allows the host computer to receive raw data sampled from the recorder's analog-to-digital converter. This data is in the range of 0 - 7FFH (0 - 2047 decimal). The data can be used as a calibration tool. The data transmitted to the communications port is in low-byte/high-byte format.

To enter the calibrate mode:

1. Send an <ESC> H (1BH, 48H) to initiate action.

2. In this mode, the host can transmit the following codes:

<CR> (0DH)	A carriage return (0DH) will cause recorder to send eight channels of data (16 bytes) in low-byte/high-byte format. One sample period is sent per <CR>.
18H	An 18H will cause the recorder to exit the calibrate mode. The recorder will transmit a (01H) code upon exiting the mode.

3-17 Datalogger Mode

The Datalogger option (DL-95) is required for the Datalogger mode. The Datalogger mode is available only in the MT-9500 recorder.

The MT-9500 can record real-time data in numeric listing format. (See paragraph 3-4.15) This real-time mode yields channel information at various speeds. Speeds can be changed by the user for trending purposes. The numeric listing is in calibrated form. Calibration units are in accordance with the last-established parameter settings of the Setup mode. This allows independent calibration of each channel in user-specified engineering units. The control code for the numeric datalogger mode is <ESC> T (1BH, 54H).

In the Datalogger mode, both the channel order and the print speed (sample period) can be changed. If the recorder is stopped, an updated time will be printed when the unit is restarted. When the speed parameter is changed, the title line is re-issued showing the speed change.

The default logging speed of the mode is 175 ms/line.

To change datalogger print speed (sample period)

1. Enter the Datalogger mode and transmit 0EH to the recorder.

2. Transmit a range code of 1-3 (31H-33H) corresponding to ms/line, sec/line, or min/line.

3. After transmitting the range code, enter a three-digit speed within the valid range. Include leading zeros as necessary.

4. MT-9500 will transmit:

05H	Error byte. Repeat from step 1.
11H	Byte accepted. Command executed.

Example: Datalogger Speed Change

Change datalogger speed to 10 seconds per line.

Host transmission: 0EH, 32H, 30H, 31H, 30H
MT-9500 response: 11H

The datalogger mode is exited by use of an 18H command. The recorder sends a 01H to the host computer to signal that it has returned to the command level and is waiting for a new mode to be initiated. See appendix D for the control codes associated with the datalogger mode.

3-18 Data-Packet Formats

Both the Synchronized Digital Data Recorder mode and the Unsynchronized Digital Data Recorder mode permit you to transfer digital data from the host computer to the recorder through a general purpose interface bus (GPIB) link.

In the Synchronized Digital Data Recorder mode, the rate of data transmission and the printing speed are synchronous. As a result, printing speed is dependent on the rate of data transmission. The recorder has a maximum operating limit of 400 hertz.

In the Unsynchronized Digital Data Recorder mode, the rate of data transmission and the printing speed are unsynchronized. Therefore, printing speed is independent of the rate of data transmission.

In each of these real-time modes, information can be sent as either control packets or data packets.

Three types of packets are available in units shipped prior to September 17, 1987: control packet, full-channel data packet, and single-channel data packet.

Four types of packets are available in units shipped after September 17, 1987 (version 1.19): control packet, full-channel data packet, single-channel data packet, and motor packet. Formatting of control packets has already been discussed but is repeated below for emphasis. Transmission of motor packets is only possible in the Synchronized Digital Data Recorder mode. Motor packets are fully discussed below.

Full-channel data packets and single-channel data packets transmitted from the host computer to the recorder require specific formats. These formats are presented after the brief data-packet descriptions that follow.

Control Packet - enables you to send command sequences to the recorder to alter its operation. A control packet consists of an ASCII C header followed by a command sequence and an EOI to indicate the end of the packet.

Motor Packet - available after September 16, 1987 (version 1.19). *Use of the motor packet is only available in the Synchronized Digital Data mode.* This packet enables you to step the chart paper a specified distance without transmitting any new digital waveform or event-marker data. The grid will continue during chart advancement. The recorded waveform will appear as a flat line from the last point sent until the appropriate distance is stepped. The event-marker information normally sent by the host will remain as last sent. The system event marker will remain active to real-time response as previously performed. The maximum stepping distance is approximately 4096 millimeters. This data packet consists of an ASCII M header, two bytes (in low byte, high byte format) that determine the distance to advance the paper, and an EOI attached to the high byte (last transfer) indicating the end of the packet.

The recorder steps the paper 16 times per millimeter. To calculate the number for count, use the following formula:

count = 16 x distance in millimeters (0.125mm increments)

Example

Step motor 16 millimeters

Count = 16 x 16 millimeters = 256 steps (00FFH)

Transmission: (4DH) (FFH) (00H)

Although the speed is normally dependant upon the data transfer, the following statistics have been included.

Motor step frequency during motor packet = 800 hertz; 50 millimeters per second.

Motor step frequency during single data packets = maximum of 800 hertz; maximum of 50 millimeters per second, controlled by transfer rate of data-packet blocks from host.

Full Channel Data Packet - permits you to transmit eight channels of data to the recorder. This data packet consists of an ASCII D header, the required amount of data, and an EOI indicating the end of the packet. See the data packet samples that follow.

Single Channel Data Packet - although this packet is primarily designed for use with the nonsynchronous data mode, it can be used to transmit one channel of data to the recorder. This data packet consists of an ASCII E header, the required amount of data, and an EOI indicating the end of the packet. The recorder will print the data and step the chart as if a full packet had been sent. See the data packet samples that follow.

Unless otherwise noted, the data-packet formats that follow are identical for both the Synchronized Digital Data Recorder mode and the Unsynchronized Digital Data Recorder mode.

MT-9500 Full Data-Packet Formats

MT-9500 8-Channel (40mm format) data-packet parameters

true channel width 50mm
center of grid 200 (00C8H)
valid range.....0-399 (0-018FH)
right edge of grid 40 (0028H)
left edge of grid 359 (0167H)

MT-9500 8-Channel (40mm) Data Packet format

byte 1 .....D (44H)	byte 2 .....event marker level
byte 3 .....ch1 low byte	byte 4 .....ch1 high byte
byte 5 .....ch2 low byte	byte 6 .....ch2 high byte
byte 7 .....ch3 low byte	byte 8 .....ch3 high byte
byte 9 .....ch4 low byte	byte 10 .....ch4 high byte
byte 11 .....ch5 low byte	byte 12 .....ch5 high byte
byte 13 .....ch6 low byte	byte 14 .....ch6 high byte
byte 15 .....ch7 low byte	byte 16 .....ch7 high byte
byte 17 .....ch8 low byte	byte 18 .....ch8 high byte (+ EOI)

MT-9500 32-Channel format data-packet parameters

true channel width *16mm*
center of grid ..... *none*
valid range ..... *0-127 (0-7FH)*
No grid

MT-9500 32-Channel Data Packet format*

byte 1 .....D (44H)	byte 2 .....unspecified
byte 3** .....ch1 data	byte 4 .....ch2 data
byte 5 .....ch3 data	byte 6 .....ch4 data
byte 7 .....ch5 data	byte 8 .....ch6 data
.....	.....
byte 33 .....ch31 data	byte 34 .....ch32 data (+ EOI)

*The event marker byte must be sent whether or not the option is installed in the system. Each bit of this byte corresponds to an event marker level for the print cycle. The first bit corresponds to the left-most event position, and so on, as viewed from the recorder's front. The system event is not controlled by this byte. It is controlled through the front- and rear-panel hardware or the "Deflecting the System Event Marker Line to Mark Data" (0CH) sequence (paragraph 3-6.5).

**In 32 channel mode, byte 3 must be sent but will not be used due to the absence of interchannel event markers. The high data byte should be zero because the valid range is 0-7FH. The data range should conform to valid range noted above.

You can change the order of the channels by rearranging the order of the waveform data within the pack.

MT-9500 Full Data-Packet Formats (continued)

MT-9500 8-Channel (Overlap) data-packet parameters

true channel width 170mm
center of grid 680 (02A8H)
valid range.....0-1359 (0-054FH)
right edge of grid 40 (0028H)
left edge of grid1 .....319 (0527H)

MT-9500 8-Channel (Overlap) Data Packet format

byte 1 .....D (44H)	byte 2 .....event marker level
byte 3 .....ch1 low byte	byte 4 .....ch1 high byte
byte 5 .....ch2 low byte	byte 6 .....ch2 high byte
byte 7 .....ch3 low byte	byte 8 .....ch3 high byte
byte 9 .....ch4 low byte	byte 10 .....ch4 high byte
byte 11 .....ch5 low byte	byte 12 .....ch5 high byte
byte 13 .....ch6 low byte	byte 14 .....ch6 high byte
byte 15 .....ch7 low byte	byte 16 .....ch7 high byte
byte 17 .....ch8 low byte	byte 18 .....ch8 high byte (+ EOI)

MT-9500 Single-Channel Data Packet

byte 1 .....E (45H)	byte 2 .....reserved
byte 3 .....event markers	byte 4 .....channel # (01 - 08H or 01 - 20H)
byte 5 .....data low byte	byte 6 .....data high byte (+ EOI)

MT-8800 Full Data-Packet Formats

MT-8800 8-Channel (20mm format) data-packet parameters

true channel width 30mm
center of grid 120 (0078H)
valid range 0-239 (0-00EFH)
right edge of grid 40 (0028H)
left edge of grid 199 (00C7H)

MT-8800 8-Channel (20mm) Data Packet format

byte 1 ..... D (44H)
byte 2 ..... event marker level
byte 3 ..... ch1 low byte
byte 4 ..... ch1 high byte
byte 5 ..... ch2 low byte
byte 6 ..... ch2 high byte
byte 7 ..... ch3 low byte
byte 8 ..... ch3 high byte
byte 9 ..... ch4 low byte
byte 10 ..... ch4 high byte
byte 11 ..... ch5 low byte
byte 12 ..... ch5 high byte
byte 13 ..... ch6 low byte
byte 14 ..... ch6 high byte
byte 15 ..... ch7 low byte
byte 16 ..... ch7 high byte
byte 17 ..... ch8 low byte
byte 18 ..... ch8 high byte

MT-8800 8-Channel (Overlap) data-packet parameters

true channel width *210mm*
center of grid ..... *840 (0348H)*
valid range ..... *0-1679 (0-67F)*
right edge of grid ..... *40 (0028H)*
left edge of grid ..... *1639 (0667H)*

MT-8800 8-Channel (Overlap) Data Packet format

byte 1 ..... D (44H)
byte 2 ..... event marker level
byte 3 ..... ch1 low byte
byte 4 ..... ch1 high byte
byte 5 ..... ch2 low byte
byte 6 ..... ch2 high byte
byte 7 ..... ch3 low byte
byte 8 ..... ch3 high byte
byte 9 ..... ch4 low byte
byte 10 ..... ch4 high byte
byte 11 ..... ch5 low byte
byte 12 ..... ch5 high byte
byte 13 ..... ch6 low byte
byte 14 ..... ch6 high byte
byte 15 ..... ch7 low byte
byte 16 ..... ch7 high byte
byte 17 ..... ch8 low byte
byte 18 ..... ch8 high byte (+ EOI)

MT-8800 4-Channel format data-packet parameters

true channel width *50mm*
center of grid ..... *200 (00C8H)*
valid range ..... *0-399 (0-018FH)*
right edge of grid ..... *40 (0028H)*
left edge of grid ..... *359 (0167H)*

MT-8800 4-Channel Data Packet format

byte 1 .....D (44H)	byte 2 .....event marker level
byte 3 .....ch1 low byte	byte 4 .....ch1 high byte
byte 5 .....ch2 low byte	byte 6 .....ch2 high byte
byte 7 .....ch3 low byte	byte 8 .....ch3 high byte
byte 9 .....ch4 low byte	byte 10 .....ch4 high byte
byte 11 .....not used*	byte 12 .....not used
byte 13 .....not used	byte 14 .....not used
byte 15 .....not used	byte 16 .....not used
byte 17 .....not used	byte 18 .....not used

*Although channels 11 - 18 are not used by the system, they must be sent to the recorder to complete the data packet.

The event marker byte must be sent whether or not the option is installed in the system. Each bit of this byte corresponds to an event marker level for the print cycle. The first bit corresponds to the left-most event position, and so on, as viewed from the recorder's front. The system event is not controlled by this byte. It is controlled through the front- and rear-panel hardware or the "Deflecting the System Event Marker Line to Mark Data" (0CH) sequence (paragraph 3-6.5).

You can change the order of the channels by reordering the waveform data within the packet.

MT-8800 Single-Channel Data Packet

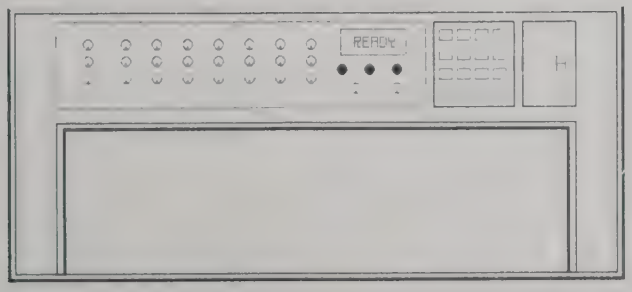
byte 1 .....E (45H)	byte 2 .....reserved
byte 3 .....event markers	byte 4 .....channel # (1 - 8 or 1 - 32)
byte 5 .....data low byte	byte 6 .....data high byte (+ EOI)

3-19 MT-9500 Plotter Mode

The plotter mode is available only in the MT-9500 recorder.

The MT-9500 can operate as a high-resolution plotter that produces a variety of graphic representations, plots, and diagrams. The figure shown below is an example of plotter mode output. The Plotter mode is available only in systems that have operating-system firmware of 12.1 or greater.

The Plotter mode allows full bit map addressability for plotting applications having a maximum print width of 180mm (approximately 7"). In the plotter mode, the printing resolution of the recorder is 200 dots/inch in both the vertical and horizontal directions. This resolution results in a 0.125mm printing element (pixel). Typical Plotter-mode applications require a software driver to convert or create the plot in accordance with the operating specifications of the MT-9500 printhead. Plotter operation permits output only on the left side of the recorder. Printing can be a maximum of 180mm in width. Paper output is governed by the number of lines of data the host computer downloads. For example, requirements for a square image would be 180 x 8 = 1440 print lines. The Plotter mode also provides a data-repetition capability.



To enter the Plotter mode

1. Send an <ESC> K (1BH, 4BH) to initiate action.

2. Transfer either data packets for printing or control packets for control functions.

Plotter-Mode Data Packets

A plotter-mode data packet contains all the information required to print one line of information.

Components of the Plotter-Mode Data Packet

ASCII	D, [count, address, string] [, ,].....[end of packet]
D	ASCII D or 44H sequence header defining data
One or more sets of:	
Count	One-byte, hexadecimal count of the number of bytes in the string. Count should be 01H - B4H (1 - 180 dec.)
Address	Hex value count (one byte) of initial byte address on print map to start storing string or data. Excess datafrom packet is accepted but not printed. Valid values are 0 - 179 or 00 - B3H.
String	Data to be placed in the print map area. Data is in hex-byte format and must be no greater than 180 bytes in length. Valid data bytes are 00 - FFH. Zero (0) is element off. One (1) is element on.
End of Packet	FFH value. The last value of the data packet.

When the data packet has been accepted, the line of information is printed by the recorder.

When exiting the Plotter mode, the recorder transmits a 01H code to the host computer indicating that the recorder has returned to the command level and is awaiting the next mode command.

Plotter-Mode Control Packets

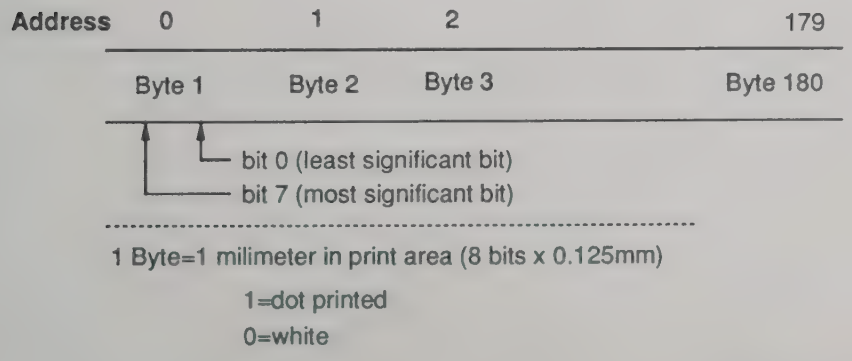
A control packet allows the user to send control code information (intermixed with data packets) to the recorder.

Components of the Plotter-Mode Control Packet

ASCII	C, code	
C	ASCII C (43H) control packet header	
Code	Control-character byte defining the control function. Valid control functions are:	
	18H	Exit Plotter mode
	0DH	Repeat previous data line

Plotter-Mode Print Map

The Plotter mode prints only on the left portion of the recorder. The physical layout of the print map is shown below. The first line transferred is the first line printed. When performing screen dumps, the last line of the display should be sent first. This will ensure proper orientation of the image.



3-20 MT-9500 Rotated Line Printer Mode

The rotated line printer mode is available only in the MT-9500 recorder.

The rotated line printer mode allows the recorder to print annotation comments in the same direction as the eight waveform channels. A maximum of 120 rows of ASCII printing characters can be placed before and/or after waveform output. Figure 3-1 is an example of the results of this mode.

The rotated line printer mode is available only in MT-9500 recorder systems with firmware levels of X3.0 or higher. During the power-up sequence, the recorder's LED display should show a message resembling <SCN 13.0>.

Follow the procedure given below to enter the rotated line printer mode. The MT-9500 accepts 132 characters per row. The recorder's total buffering capability per printing sequence is 15,840 bytes (132 x 120). Printing is performed on command.

Command: Enter the Rotated Line Printer mode

1. Send an <ESC B> (1BH, 42H) command sequence.

   The recorder will now accept ASCII control characters.

2 Enter ASCII characters from the valid range of 20 - 7FH.

   Data are accepted row by row and placed in a buffer. Send a maximum of 132 characters per row and a maximum of 120 rows. Excess characters are accepted but are niether stored nor printed.

3. Send the print command (0CH).

   The recorder immediately begins printing. The width of the output is controlled by the size of the largest character row transferred.

11:29:48 06 FEB 88 SPD: 25 MM/S TI
CHANNEL #1 LEFT WING FLAP #023 DELTA TEST
DATE: 01-01-88 TIME: 12:30 pm SITE: Somewhere, USA
TEST RECORD # 1023-12 OPERATOR: KHA #5067-1
FAILURES: 00 WARNINGS: 01
CHANNEL #2 LEFT WING FLAP #023 DELTA TEST
DATE: 01-01-88 TIME: 12:30 pm SITE: Somewhere, USA
TEST RECORD # 1023-12 OPERATOR: KHA #5067-1
FAILURES: 00 WARNINGS: 01
CHANNEL #3 LEFT WING FLAP #023 DELTA TEST
DATE: 01-01-88 TIME: 12:30 pm SITE: Somewhere, USA
TEST RECORD # 1023-12 OPERATOR: KHA #5067-1
FAILURES: 00 WARNINGS: 01
CHANNEL #4 LEFT WING FLAP #023 DELTA TEST
DATE: 01-01-88 TIME: 12:30 pm SITE: Somewhere, USA
TEST RECORD # 1023-12 OPERATOR: KHA #5067-1
FAILURES: 00 WARNINGS: 01

Figure 3-1. Example of Rotated Line Printer Mode

Control characters for the Rotated Line Printer mode include:

(0DH) - Carriage return
sets cursor back to the first column

(0AH)- Line feed
advances cursor to next row and same column

(0CH) Print
ends input and prints buffer content

(0BH) Exit
recorder exits rotated line printer mode and returns to command level

Example: Rotated Line Printer

1.	Enter mode.	(1BH, 42H)
2.	Advance paper two columns	(09H, 09H)
3.	Send lines of data	TEST LINE 1 <CR><LF> TEST LINE 2 <CR><LF> ..... TEST LINE 9 <CR><LF>
4.	Print buffer contents	(0CH)
5.	Exit the mode to command level	(0BH)
6.	MT-9500 returns an 01H	

Section 4
Exiting Host-Control Operation

The recorder can return to local control in one of two ways: manually or by host-computer command. The front panel keypad provides a manual method for exiting host-control. When exiting host-control from the host computer, the recorder should be idle. No transmissions between hostcomputer and recorder should occur before starting either exit sequence.

Manual Method

1. **Press [F2] to set communications (SET COMM).**

2. **Press [ENTER] on the front keypad.**

3. **Scroll to <KEYPAD> and press [ENTER].**

4. **The display will read <WAIT> and will then change to <READY>.**

   This indicates that the recorder has returned to local control.

Host Control Method

To exit host-control operation from the host computer, the host computer must enter the Setup mode as described in the paragraph 3-4. When the Setup mode has been entered, the host computer must send a 1FH to the recorder . No further communication is required. After a momentary delay, the recorder will return to local operation. Virtually all parameter settings of the recorder remain as last set by the host computer.

Appendix A

MT-9500 Factory-Installed Optional Features

MT-9500 Factory-Installed Optional Features

Model	Description
DC-95	Data Capture capability. Provides 128K sample memory.
AP-95	Alpha-numeric Printing capabilty. Provides eight 60-character text buffers for chart annotation.
EM-95	Event Marker capability. Provides eight additional TTL-low/switch-closure event channels (9 total).
OM-95	Overlap mode. Allows channels to be overlapped four each on two 160mm-wide grids.
OG-95	50 Division Grids in 8-channel mode (in lieu of 40 division grid).
IRIG-95	Allows the recorder to decode modulated or demodulated IRIG A, B, H, or NASA 36 time codes and print text on chart.
DI-488-95	Digital interface capability. Allows up to thirty-two 8-bit digitized waveforms to be entered via the standard IEEE-488 interface.
DL-95	Provides real-time numeric values in user-programmable engineering units.

Appendix B

MT-8800/9000 Factory-Installed Optional Features

MT-8800/9000 Factory-Installed Optional Features

Model	Description
DC-95	Data Capture capability. Provides 128K sample memory.
IRIG-95	Allows the recorder to decode modulated or demodulated IRIG A, B, H, or NASA 36 time codes and print text on chart.
DI-488-95	Digital Interface capability. Allows up to thirty-two digitized waveforms to be entered via the standard IEEE-488 interface.

Appendix C

DIP Switch Settings for the IRIG Option

DIP Switch Settings for the IRIG Option

	S1	S2	S3	S4	S5	S6	S7	S8
Normal Time	on	on	*	off	off	*	X	X
IRIG A	off	on	*	off	off	*	X	X
IRIG B	on	off	*	off	*	*	X	X
IRIG H	off	off	*	off	off	*	X	X
NASA 36	on	on	*	on	*	*	X	X
Remote Start/Stop:								
enable	*	*	on	*	*	*	X	X
disable	*	*	off	*	*	*	X	X
System Log Print Control:								
synchronized†					on	*	X	X
unsynchronized††					off	*	X	X
Communications Setup:								
original GPIB or RS-232	*	*	*	*	*	off	X	X
enhanced GPIB	*	*	*	*	*	on	X	X

†IRIG B and NASA 36 only. ††All time codes.

X = switches reserved for future use.
They should be placed in the "off" position.

Appendix D

Control Codes for Host-Control Operation

D-1. Control Codes for Analog Real-Time Recorder Mode

Hex Equiv	Control Character	Description
00	@	Null
01	A	reserved
02	B	reserved
03	C	System print channel on/off
04	D	reserved
05	E	Turn system event marker on/off
06*	F	Event markers on/off sequence
07	G	reserved
08	H	reserved
09	I	Print ID on the waveforms
0A	J	reserved
0B	K	reserved
0C	L	System event marker hi/lo
0D	M	Carriage return
0E	N	New motor speed sequence
0F*	O	Event markers hi/lo sequence
10*	P	Print channel messages once
11	Q	reserved
12	R	reserved
13	S	Start/stop recorder toggle
14	T	reserved
15*	U	Start auto repeat of channel message
16*	V	Stop auto repeat of channel message
17*	W	Write print channel data to print buffers
18	X	Exit real-time mode to command level
19	Y	reserved
1A	Z	reserved
1B	[	reserved
1C	\	reserved
1D	]	reserved
1E	^	reserved
1F	-	reserved

*Denotes a control function requiring installation of an MT-9500 option.

Table D-2. Control Codes for Setup Mode

Hex Equiv	Control Character	Description	Default on Host Control
00	@	reserved	
01	A	Channel grid on/off	enabled
02	B	Set channel order sequence	1 thru 8
03*	C	Snapshot time base sequence	1 ms/mm
04*	D	Data storage/window size sequence	8 channel/ 8k sample
05*	E	Window/trigger relationship	start
06*	F	Define X-Y channels sequence	1,2
07*	G	Annotation/Event marker sequence	option dependent
08*	H	Magnification/Expansion	1x
09*	I	Trigger enabling/disabling	enabled
0A*	J	Snapshot time-base/frequency source	internal
0B	K	Trigger channel input	channel #1
0C*	L	Playback percentage	0% - complete
0D	M	Used to terminate most control sequences	
0E	N	Signal inversion definition	8 normal
0F*	O	Real-time recorder motor speed definition	internal
10*	P	In MT-9500: Numeric listing calibration	+200 to -200
10	P	In MT-8800: reserved	
11*	Q	Signal conditioner status on/off	8 off
12	R	reserved	
13	S	reserved	
14	T	reserved	
15	U	reserved	
16	V	reserved	
17	W	reserved	
18	X	Exit setup sequence	
19	Y	reserved	
1A	Z	reserved	
1B	[	reserved	
1C	\	reserved	

*Denotes a command requiring installation of an MT-9500 option.

Table D-3. Control Codes for Line Printer Mode

Hex Equiv	Control Character	Description
09	I	Horizontal tab
0A	J	Line feed
0B	K	Exit line printer mode command
0C	L	Formfeed
0D	M	Carriage return

All other control characters will yield a printable symbol.

Table D-4. Control Codes for Data-Capture Mode

Hex Equiv	Control Character	Description
18	X	Exit to command level

Note 1: The Data-Capture Mode of the recorder requires the installation of the data-capture option.

Note 2: Any transmission from the host will cause the recorder to exit (abort) the current acquisition.

Note 3: After completing a host-configured trace, the recorder will perform an automatic exit process and return to command level. The recorder will transmit a (01H) after completing the trace or after an aborted trace.

Table D-5. Control Codes for Playback Mode

Hex Equiv	Control Character	Description
00	@	Null
01	A	reserved
02	B	reserved
03	C	System print channel on/off
04	D	reserved
05	E	reserved
06	F	reserved
07	G	reserved
08	H	reserved
09	I	Print ID on the waveform
0A	J	reserved
0B	K	reserved
0C	L	reserved
0D	M	Carriage return
0E	N	reserved
0F	O	reserved
10*	P	Print channel message once
11	Q	reserved
12	R	reserved
13	S	Start/stop recorder toggle
14	T	reserved
15*	U	Start auto repeat of channel message
16*	V	Stop auto repeat of channel message
17*	W	Write print channel data to print buffers
18	X	Exit playback mode to command level
19	Y	reserved
1A	Z	reserved
1B	[	reserved
1C	\	reserved
1D	]	reserved
1E	^	reserved
1F	-	reserved

*Denotes a control function requiring installation of a recorder option.

Note: After the recorder has completed playing back the specified portion of the window, the recorder will perform an automatic exit sequence and inform the host with a (01H) code.

Table D-6. Control Codes for Playback Mode

Hex Equiv	Control Character	Description
0D	M	Carriage return
13	S	Start/stop recorder toggle
18	X	Exit playback mode to command level

Notes: After completing a playback, the recorder will perform an automatic exit sequence and inform the host by a code (01H).

In the MT-9500 recorder these control codes pertain to X-Y Plot and Numeric formats.

In MT-8800/9000 recorders, these control codes pertain to the X-Y Plot format.

Table D-7. Control Codes for Calibrate Mode

Hex Equiv	Control Character	Description
0DH	M	Carriage return initiates sending of data
18H	X	Exit calibrate mode to command level

Table D-8. Control Codes for Synchronized Digital-Data Recorder Mode

Hex Equiv	Control Character	Description
00	@	reserved
01	A	reserved
02	B	reserved
03	C	System print channel on/off
04	D	reserved
05	E	Turn system event marker on/off
06*	F	Event markers on/off sequence
07	G	reserved
08	H	reserved
09	I	Print ID on the waveforms
0A	J	reserved
0B	K	reserved
0C	L	System event marker hi/lo
0D	M	Carriage return
0E	N	reserved
0F	O	reserved
10*	P	Print channel messages once
11	Q	reserved
12	R	reserved
13	S	reserved
14	T	reserved
15*	U	Start auto repeat of channel message
16*	V	Stop auto repeat of channel message
17*	W	Write print channel data to print buffers
18	X	Exit real-time mode to command level
19	Y	reserved
1A	Z	reserved
1B	[	reserved
1C	\	reserved
1D	]	reserved
1E	^	reserved
1F	-	reserved

*Denotes a control function requiring installation of an MT-9500 option.

Note: Digital Data Recorder modes require installation of the DI-488-95 option.

Table D-9. Control Codes for Unsynchronized Digital-Data Recorder Mode

Hex Equiv	Control Character	Description
00	@	reserved
01	A	reserved
02	B	reserved
03	C	System print channel on/off
04	D	reserved
05	E	Turn system event marker on/off
06*	F	Event markers on/off sequence
07	G	reserved
08	H	reserved
09	I	Print ID on the waveforms
0A	J	reserved
0B	K	reserved
0C	L	System event marker hi/lo
0D	M	Carriage return
0E	N	New motor speed sequence
0F	O	reserved
10*	P	Print channel messages once
11	Q	reserved
12	R	reserved
13	S	Start/stop recorder toggle
14	T	reserved
15*	U	Start auto-repeat of channel message
16*	V	Stop auto-repeat of channel message
17*	W	Write print channel data to print buffers
18	X	Exit real-time mode to command level
19	Y	reserved
1A	Z	reserved
1B	[	reserved
1C	\	reserved
1D	]	reserved
1E	^	reserved
1F	-	reserved

*Denotes a control function requiring installation of an MT-9500 option.

Note: Digital Data Recorder modes require installation of the DI-488-95 option.

Table D-10. Control Codes for Datalogger Mode

Hex Equiv	Control Character	Description
0E	N	New motor speed sequence
13	S	Start/stop recorder toggle
18	X	Exit playback mode to command level

Note: This mode pertains to the MT-9500 recorders only.

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